Direct Drive Robot

User Guide

Original Instructions

Agilent Technologies

Notices

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hereby declares that:
equipment model: Direct Drive Robot

complies with the essential requirements of the following European Directives and bears the CE Marking accordingly:

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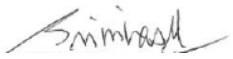
Low Voltage Directive 2006/95/EC

and conforms with the following product standards:

EMC: IEC 61326-1:2005 / EN 61326-1:2006
Safety: IEC 61010-1:2001 / EN 61010-1:2001



_____ Santa Clara, CA December 18th, 2009
Bob Srinivas
Quality Manager

Language in the EC Declaration of Incorporation

The EC Declaration of Incorporation (for partial machinery) accompanying the Direct Drive Robot includes the following language:

Agilent Technologies hereby declares that the:

- Equipment — Direct Drive Robot
- Serial number — Shown on the equipment

is incomplete machinery, and must not be put into service until the machinery into which it is to be incorporated has been declared in conformity with the provisions of Machinery Directive 2006/42/EC. The equipment complies with all applicable Essential Health and Safety Requirements (EHSRs) except:

1.2.4.3 — Emergency stop
1.3.1 — Stability
1.3.7 — Moving parts
1.3.8 — Guards

We undertake to transmit, via email, relevant information on the partly completed machinery in response to a reasoned request by national authorities.

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Preface

This preface contains the following topics:

- "About this guide" on page x
- "Accessing Automation Solutions user guides" on page xii

About this guide

Who should read this guide

This user guide is for people with the following job roles:

Job role	Responsibilities
Installer	Unpacks, installs, and tests the Direct Drive Robot before it is used.
Integrator	Writes software and configures hardware controlled by the VWorks software.
Lab manager, administrator, or technician	• Manages the automation system that contains the Direct Drive Robot • Develops the applications that are run on the system • Develops training materials and standard operating procedures for operators
Operator	Performs the daily production work on the system that contains the Direct Drive Robot.

Installers, integrations, lab managers, and administrators are users who must have technical expertise. In addition, lab managers and administrators are individuals or groups responsible for the use and maintenance of the Direct Drive Robot and for ensuring that operators are adequately trained.

What this guide covers

This guide describes the Direct Drive Robot, the operation of the hardware components, and the use of the diagnostics software.

This guide does not provide instructions for the following:

- VWorks software or third-party software
- Agilent Technologies devices, such as the Bravo Automated Liquid Handling Platform, PlateLoc Thermal Microplate Sealer, Microplate Seal Piercer, Microplate Labeler, Vertical Pipetting Station, Microplate Centrifuge, and Labware Stacker.
- Third-party devices

For more information about these topics, see the relevant user guides for these products.

Software version

This guide documents the following:

- DDR Diagnostics version 1.2.x or later
- Robot firmware version 1.2.x or later
- Gripper firmware version 2.3 or later

Related guides

The *Direct Drive Robot User Guide* should be used in conjunction with the following documents:

- *Direct Drive Robot Site Preparation and Safety Guide*. Provides the Direct Drive Robot specifications and site requirements. The guide also describes the potential safety hazards and how to avoid them.
- *VWorks Automation Control Setup Guide*. Explains how to install the VWorks software, define labware, track labware, and manage users.
- *VWorks Automation Control User Guide*. Explains how to add devices, create protocols, set task parameters, and run protocols.
- *VWorks Software Quick Start*. Provides an overview of how to use the VWorks Automation Control software.
- *Automation Solutions device user guides*. Explains how to set up and use the Automation Solutions devices.
- *Third-party device user documents*. Explains how to set up and use the third-party devices.

Related information

For information about...	See...
Accessing related user guides	"Accessing Automation Solutions user guides" on page xii
Reporting problems	"Reporting problems" on page 217

Accessing Automation Solutions user guides

About this topic

This topic describes the different formats of Automation Solutions user information and explains how to access the user information.

Where to find user information

The Automation Solutions user information is available in the following locations:

- *Knowledge base*. The help system that contains information about all of the Automation Solutions products is available from the Help menu within the VWorks software.
- *PDF files*. The PDF files of the user guides are installed with the VWorks software and are on the software CD that is supplied with the product. A PDF viewer is required to open a user guide in PDF format. You can download a free PDF viewer from the internet. For information about using PDF documents, see the user documentation for the PDF viewer.
- *Agilent Technologies website*. You can search the online knowledge base or download the latest version of any PDF file from the Agilent Technologies website at www.agilent.com/lifesciences/automation.

Accessing safety information

Safety information for the Agilent Technologies devices appears in the corresponding device user guide.

You can also search the knowledge base or the PDF files for safety information.

Using the knowledge base

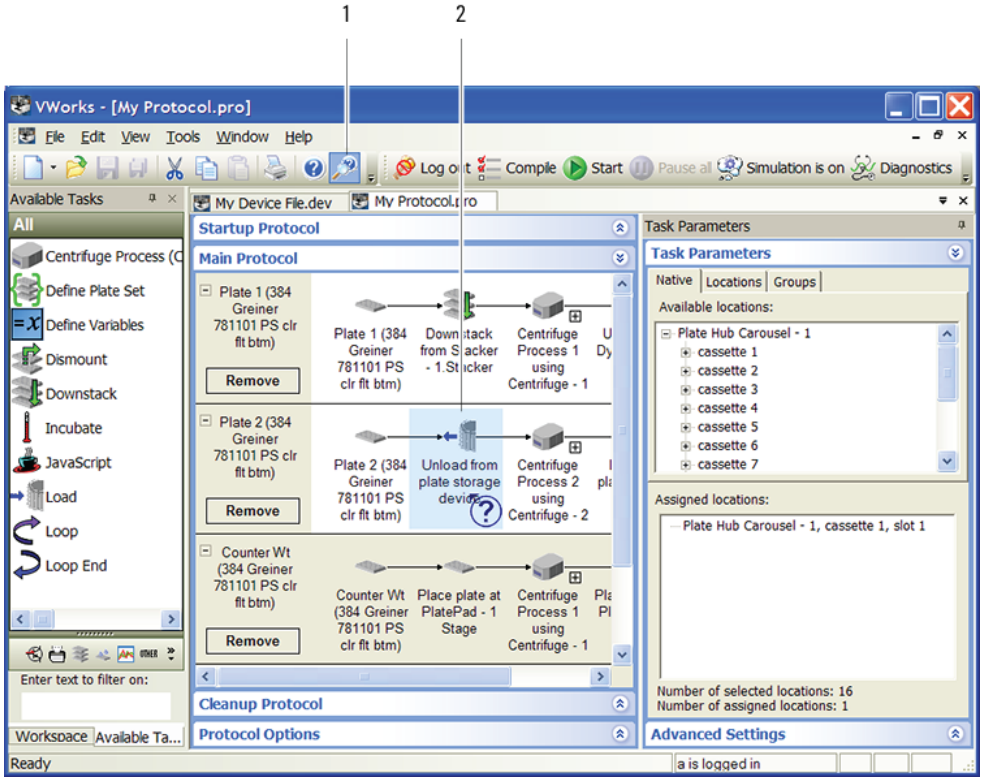
Knowledge base topics are displayed using web browser software such as Microsoft Internet Explorer and Mozilla Firefox.

Note: If you want to use Internet Explorer to display the topics, you might have to allow local files to run active content (scripts and ActiveX controls). To do this, in Internet Explorer, open the **Internet Options** dialog box. Click the **Advanced** tab, locate the **Security** section, and select **Allow active content to run in files on my computer.**

To open the knowledge base, do one of the following:

- From within VWorks software, select **Help** > **Knowledge Base** or press F1.
- From the Windows desktop, select **Start** > **All Programs > Agilent Technologies > VWorks** > **User Guides** > **Knowledge Base.**

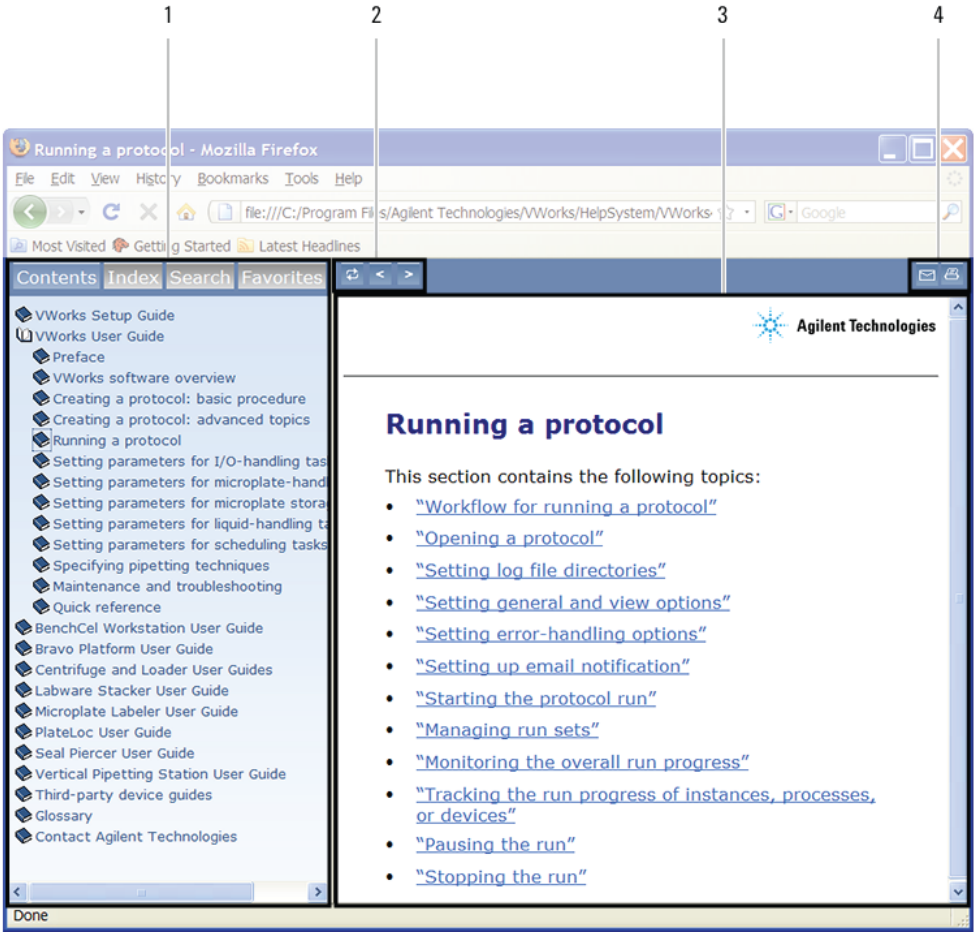
Opening the help topic for an area in the VWorks window



To access the context-sensitive help feature:

1. In the main window of the VWorks software, click the help button . The pointer changes to . Notice that the different icons or areas are highlighted as you move the pointer over them.
2. Click an icon or area of interest. The relevant topic or document opens.

Features in the Knowledge Base window



Item	Feature
1	*Navigation area.* Consists of four tabs: • *Contents.* Lists all the books and the table of contents of the books. • *Index.* Displays the index entries of all of the books. • *Search.* Allows you search the Knowledge Base (all products) using keywords. You can narrow the search by product. • *Favorites.* Contains bookmarks you have created.
2	*Navigation buttons.* Enable you to navigate through the next or previous topics listed in the Contents tab.
3	*Content area.* Displays the selected online help topic.
4	*Toolbar buttons.* Enable you to print the topic or send documentation feedback by email.

Related information

For information about...	See...
Who should read this guide	“About this guide” on page x
What this guide covers	“About this guide” on page x
Reporting problems	“Reporting problems” on page 217

1 Introduction to the Direct Drive Robot

This chapter contains the following topics:

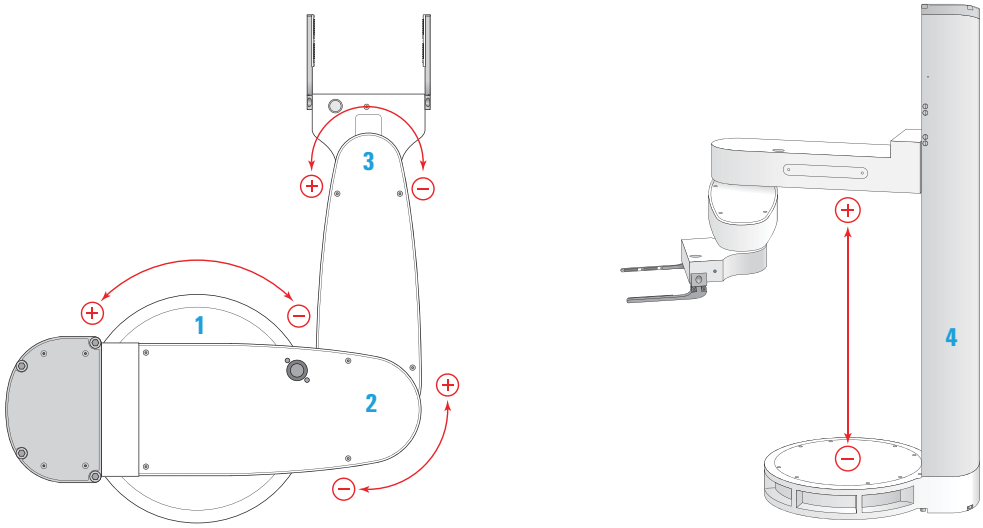
- "About the Direct Drive Robot" on page 2
- "Hardware components" on page 4
- "Software overview" on page 11

About the Direct Drive Robot

Description

The Direct Drive Robot is designed to move labware in a laboratory environment. The robot has four axes of motion and is able to grip labware in both the landscape and portrait orientations.

Figure Direct Drive Robot axes of movements (top view and side view)



Item	Axis	Description of robot movement
1	Waist	Robot arm rotates infinitely about the waist.
2	Elbow	Robot forearm rotates infinitely about the elbow.
3	Wrist	Robot hand rotates infinitely about the wrist.
4	Mast	Robot arm moves up and down along the mast.

The Direct Drive Robot is controlled by the VWorks software and the DDR Diagnostics plugin. For more information about the software, see "Software overview" on page 11.

Before you operate the system

WARNING **For safe operation, it is imperative that you follow the precautions in the *Direct Drive Robot Site Preparation and Safety Guide*.**

Related information

For information about...	See...
Direct Drive Robot features	"Hardware components" on page 4
Direct Drive Robot specifications	"Specifications and site requirements" on page 13
Software that controls the Direct Drive Robot	"Software overview" on page 11
Safety information	*Direct Drive Robot Site Preparation and Safety Guide*

Hardware components

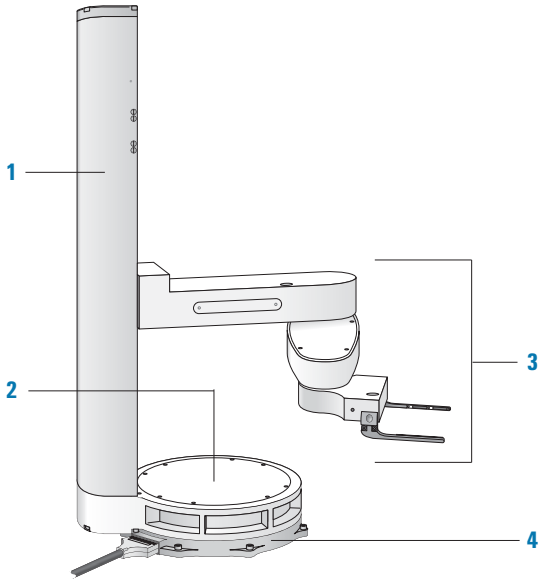
About this topic

This topic describes the following Direct Drive Robot hardware features:

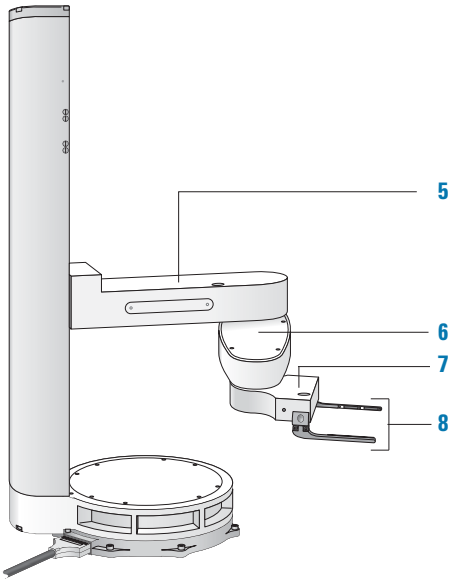
- Main components
- Microplate sensor
- Gripper lead screw locations
- Power supply
- Emergency stop pendant
- Teaching jig
- Regrip station

Main components

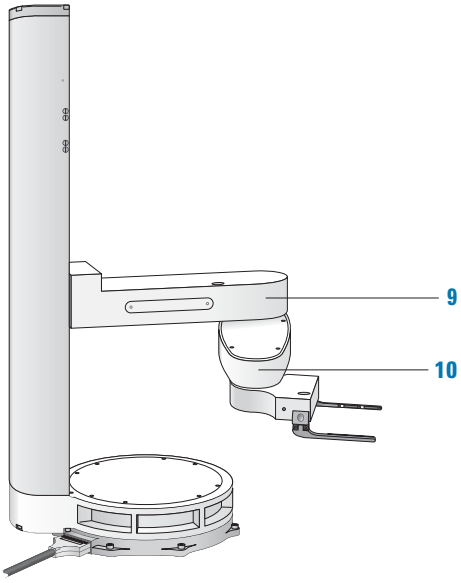
The following diagrams show the main components of the Direct Drive Robot.



Item	Name	Description
1	Mast	The vertical structure along which the robot arm moves up and down.
2	Waist	The round structure about which the entire robot moves.
3	Arm	The appendage that consists of the bicep, forearm, hand, and grippers.
4	Base	The gray octagonal plate that attaches the robot to the target surface.



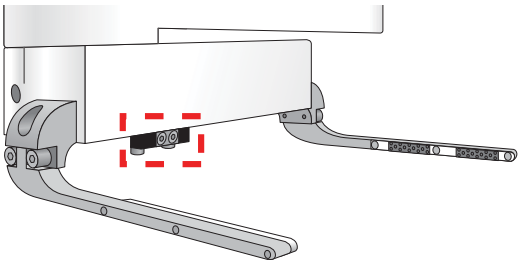
Item	Name	Description
5	Bicep	The upper segment of the arm that moves up and down along the mast.
6	Forearm	The lower segment of the arm that rotates about the elbow.
7	Hand	The component of the robot that rotates about the wrist.
8	Grippers	The two finger-like structures that open and close to pick up or place labware.



Item	Name	Description
9	Elbow	The joint that connects bicep and forearm. The forearm rotates about this joint.
10	Wrist	The joint that connects the forearm to the hand. The hand rotates about this joint.

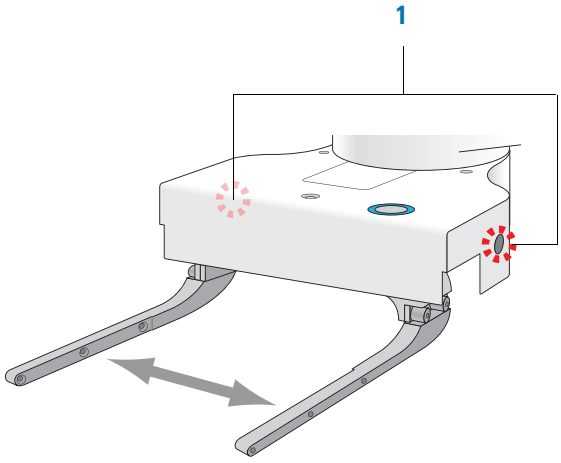
Microplate sensor

The microplate sensor under the robot hand is used to detect the presence of labware in its grip. For more information, see "Checking the robot microplate sensor" on page 159.



Gripper lead screw locations

Two gripper lead screws on both sides of the robot hand enable you to manually open and close the robot grippers. You need to manually open and close the grippers when setting teachpoints or during troubleshooting. For information about setting teachpoints, see "Setting teachpoints" on page 88. To change the target open and close positions, see "Changing the gripper settings" on page 156.



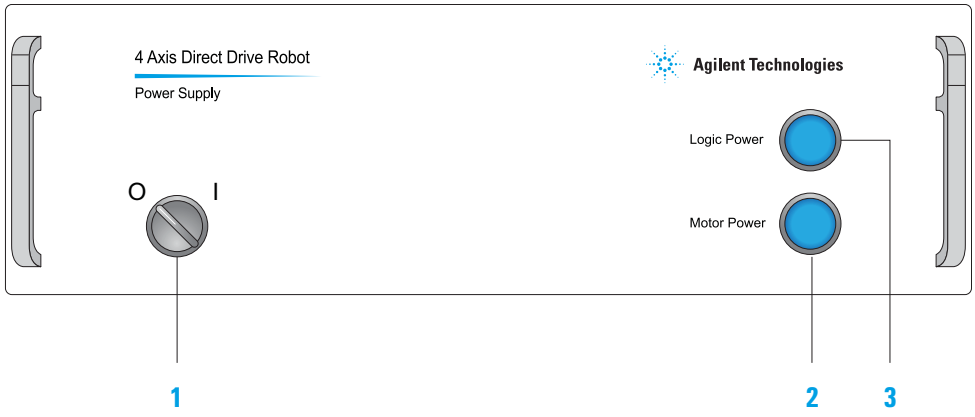
Power supply

The robot power supply is the component that supplies electrical power to the robot and is the communication connection between the robot and the controlling computer.

The robot is supplied with power supply G5411-60010 or G5411-60005. The front of the two models are identical. The two models have different arrangement of connectors in the back.

Power switch and indicator lights

The following diagram shows the front of the robot power supply.



Item	Label	Description
1	Power	Power switch. To turn on the robot, turn the switch to the on (I) position. To turn off the power, turn the switch to the off (O) position.
2	Motor power	Robot motor indicator light. When the light is on, the robot motor is enabled. When the light is off, the robot motor is disabled. To enable or disable the robot, use the Enable robot motor or the Disable robot motor button in the DDR Diagnostics software.
3	Logic power	Robot power indicator light. When the light is on, the robot power is on. If the light is off, the robot power is off.

Power and communication connections

The following diagrams show the back of power supply G5411-60010 and G5411-60005. The model number is displayed on the serial number label (5).

Figure Power supply G5411-60010

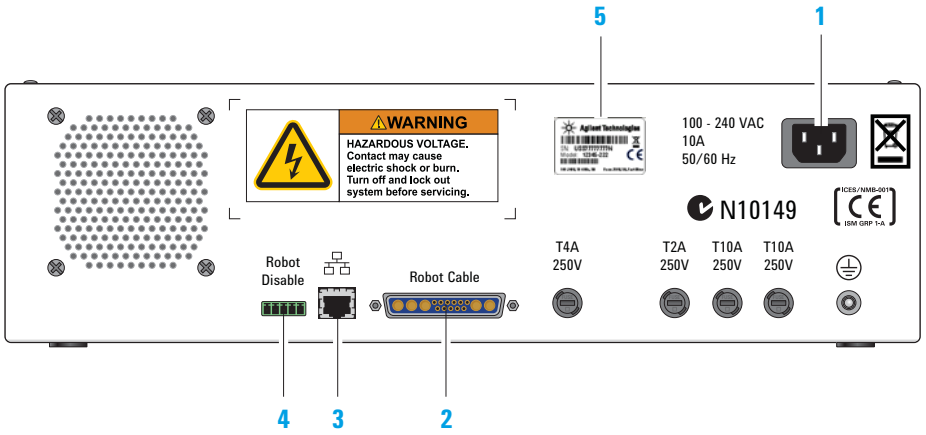
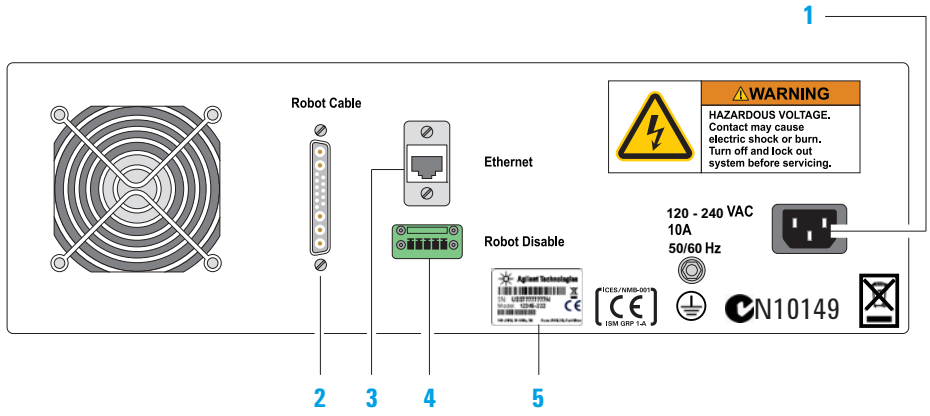


Figure Power supply G5411-60005



Item	Label	Description
1	Power inlet	Connects the power supply unit to the power source. Use the supplied power cord.
2	Robot Cable	Connects the robot to the power supply unit. Use the supplied robot cable.
3	Ethernet	Connects the robot to the controlling computer. The power supply unit houses a 10/100 BaseT Ethernet adapter and an RJ-45 receptacle connection. The Ethernet cable is not supplied.
4	Robot disable	Connects the emergency stop pendant to the power supply unit. Use the supplied emergency stop pendant cable.
5	Serial number label	Contains the power supply model number (G5411-60010 or G5411-60005) and serial number.

Emergency stop pendant

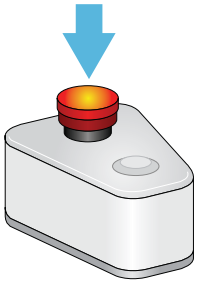
The Direct Drive Robot is equipped with an emergency stop pendant. Pressing the red button on the pendant cuts power to the robot motors and stops the robot during an emergency.

If the robot is integrated with other devices in a system, Agilent Technologies recommends that you install a main emergency stop button to cut power to the robot and all devices simultaneously.

For detailed safety information, see the *Direct Drive Robot Site Preparation and Safety Guide*. For instructions on how to recover from an emergency stop, see "Recovering from an emergency stop" on page 198.

Note: The silver button is not used.

Figure Emergency stop pendant.



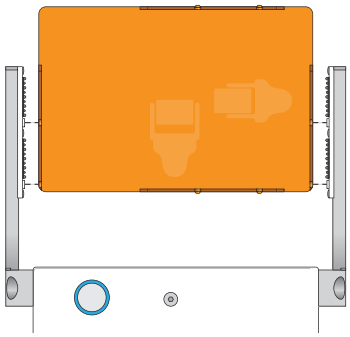
Teaching jig

Supplied with the Direct Drive Robot, the teaching jig allows you to set teachpoints quickly and accurately. The teaching jig can be used for setting teachpoints in the landscape (1) or portrait orientation (2).

For instructions on how to use the teaching jig to set teachpoints, see "Setting teachpoints" on page 77.

Note: If size restrictions at teachpoints prevent the use of the teaching jig, you can use the labware intended for the location. For more information, see "Setting teachpoints using a labware" on page 107.

1



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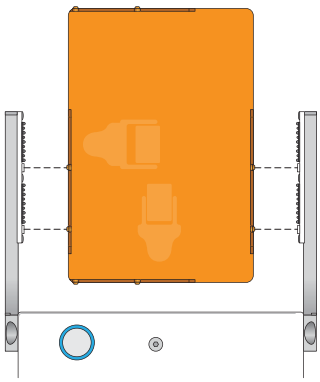
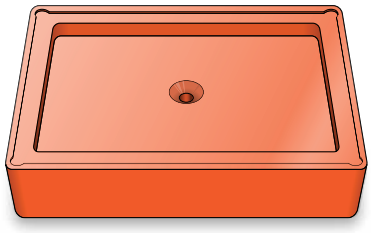


Regrip station

A regrip station is a platepad that the robot uses to:

- Change the labware (landscape/portrait) or A1-well orientation between teachpoints that require different orientations.
- Adjust its grip at the specified labware gripping height. The location is typically used after a robot picks up a labware higher than the specified gripping height because of physical restrictions at a teachpoint.



For more information about designating the platepad as a regrip station, see "Designating a teachpoint as a regrip station" on page 97.

Related information

For information about...	See...
Direct Drive Robot description	"About the Direct Drive Robot" on page 2
Robot specifications	"Specifications and site requirements" on page 13
Safety information	*Direct Drive Robot Site Preparation and Safety Guide*

Software overview

About this topic

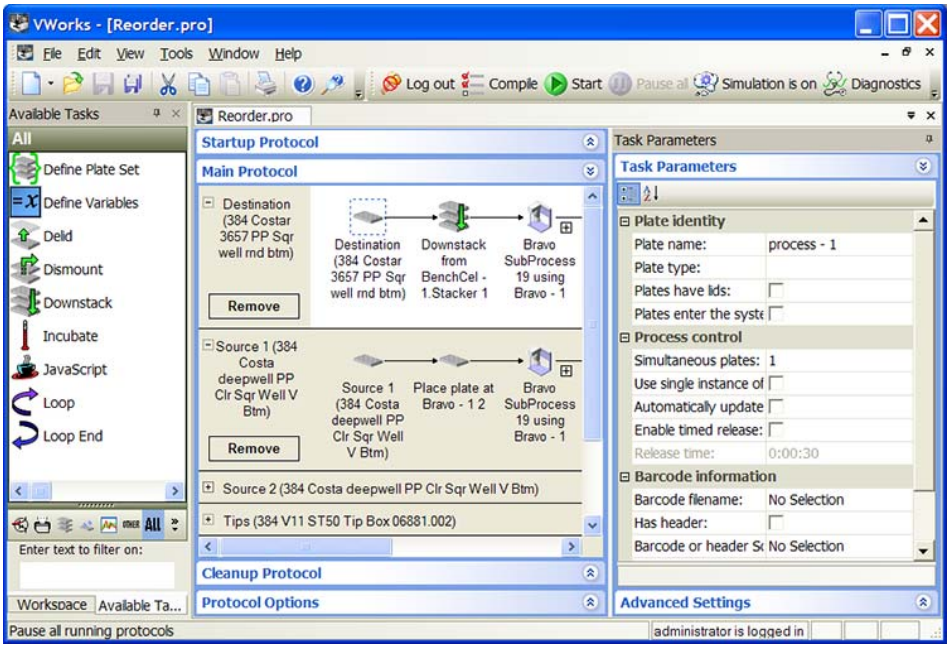
You use the VWorks software and DDR Diagnostics software to set up, operate, and troubleshoot the Direct Drive Robot. This topic describes the VWorks software and DDR Diagnostics software.

VWorks software

The VWorks software allows you to:

- *Set up the Direct Drive Robot.* During setup, you need to create a device file for the Direct Drive Robot robot and integrated devices. For setup information, see "Setting up the Direct Drive Robot" on page 49.
- *Set up user accounts and privileges.* You can set up different user accounts to enforce access policies. For instructions, see the *VWorks Automation Control Setup Guide*.
- *Define labware.* Labware definitions describe the labware you will use during protocol runs. For instructions, see the *VWorks Automation Control Setup Guide*.
- *Create protocols.* Protocols determine the sequence of tasks you want to automate in a run. For example, you can use a protocol to apply barcode labels to 100 microplates. For protocol-writing instructions, see the *VWorks Automation Control User Guide*.
- *Run, pause, monitor, and stop protocols.* You can start, pause, monitor, and stop a protocol run from the controlling computer.

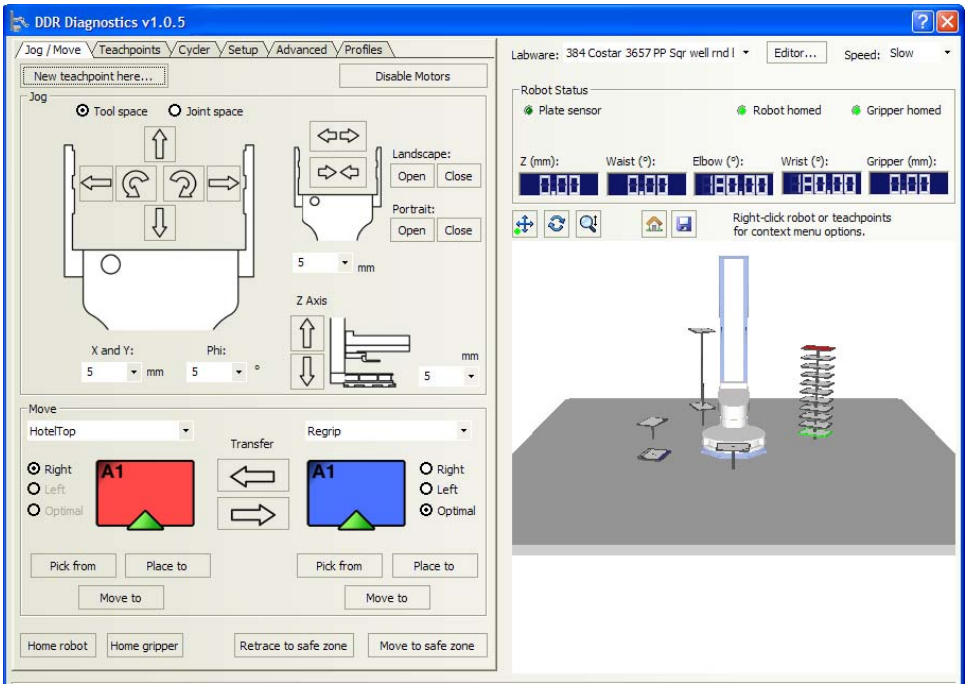
For a full description and instructions on how to use the VWorks software, see the *VWorks Automation Control User Guide*.



Robot diagnostics software

Accessed through the VWorks software, the DDR Diagnostics software allows you to:

- *Create and manage profiles.* Robot profile allows you to set up communication between the robot and the controlling computer. You create the profile when you set up the robot. For setup information, see "Setting up the Direct Drive Robot" on page 49.
- *Set and edit teachpoints.* Teachpoints are locations that the Direct Drive Robot robot will go to and from during a protocol run. You set teachpoints when you set up the Direct Drive Robot. You can also edit the teachpoints to correct or fine-tune the original teachpoints. For teachpoint setup and editing information, see "Setting teachpoints" on page 77.
- *Diagnose problems.* Moving and adjusting individual hardware components allow you to diagnose and troubleshoot problems. For information on diagnosing and troubleshooting problems, see "Using DDR Diagnostics" on page 137.



Related information

For information about...	See...
VWorks software instructions	*VWorks Automation Control User Guide*
Direct Drive Robot description	"About the Direct Drive Robot" on page 2
Robot specifications	"Specifications and site requirements" on page 13
Hardware components	"Hardware components" on page 4

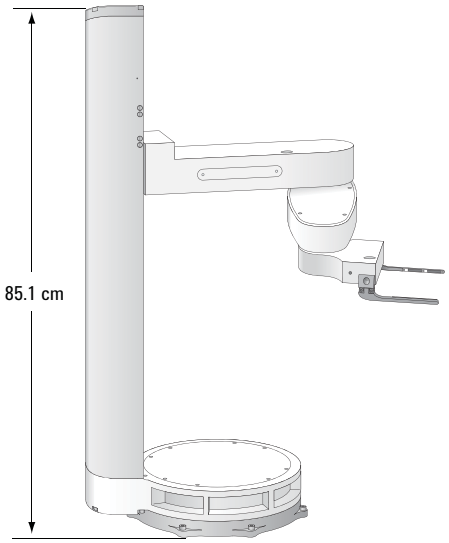
2 Specifications and site requirements

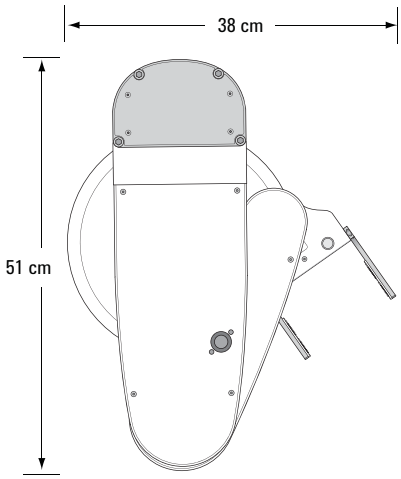
This chapter contains the following topics:

- "Physical dimensions" on page 14
- "Reach and workspace" on page 18
- "Axis and gripper specifications" on page 21
- "Performance specifications" on page 23
- "Mounting specifications" on page 24
- "Electrical requirements" on page 27
- "Environmental requirements" on page 28
- "Computer requirements" on page 29

Physical dimensions

Robot dimensions



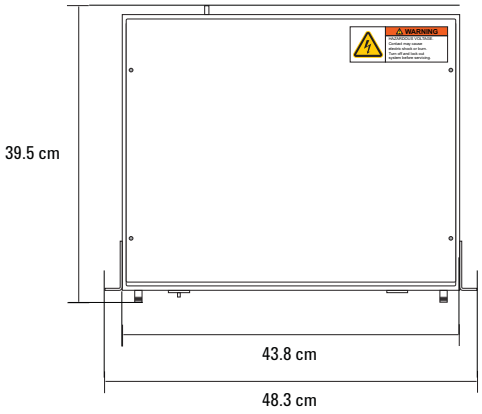


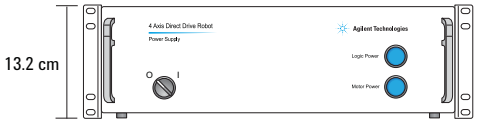
Dimension	Value
Height	85.1 cm (33.5 in)
Width (home position)	51 cm (20 in)
Depth (home position)	38 cm (15 in)
Weight	31.1 kg (68.5 lb)

Grippers: 6 mm thick titanium, with replaceable rubber gripping pads
Robot cable: 2.4 m (8.0 ft), 1.2 kg (2.6 lb)

Power supply dimensions

Power supply (G5411-60010)

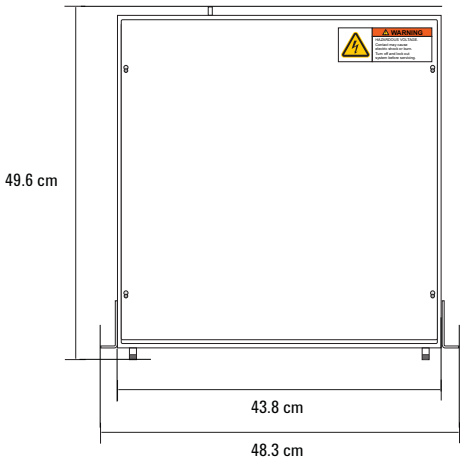


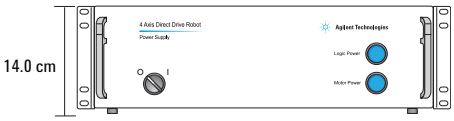


Dimension	Value
Width:	
Without mounting bracket	43.8 cm (17.3 in)
With mounting bracket	48.3 cm (19.0 in)
Depth	39.5 cm (15.5 in)
Height	13.2 cm (5.2 in)
Weight	9.7 kg (21.4 lb)

Power cord: 2 m (6 ft)

Power supply (G5411-60005)

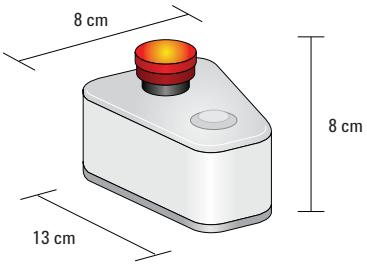




Dimension	Value
Width	
Without mounting bracket	43.8 cm (17.3 in)
With mounting bracket	48.3 cm (19.0 in)
Depth	49.6 cm (19.5 in)
Height	14.0 cm (5.5 in)
Weight	13.8 kg (30.4 lb)

Power cord: 2 m (6 ft)

Emergency-stop pendant dimensions



Dimension	Value
Width	8 cm (3 in)
Depth	13 cm (5 in)
Height	8 cm (3 in)

Emergency stop pendant cable: 2 m (6 ft)

Related information

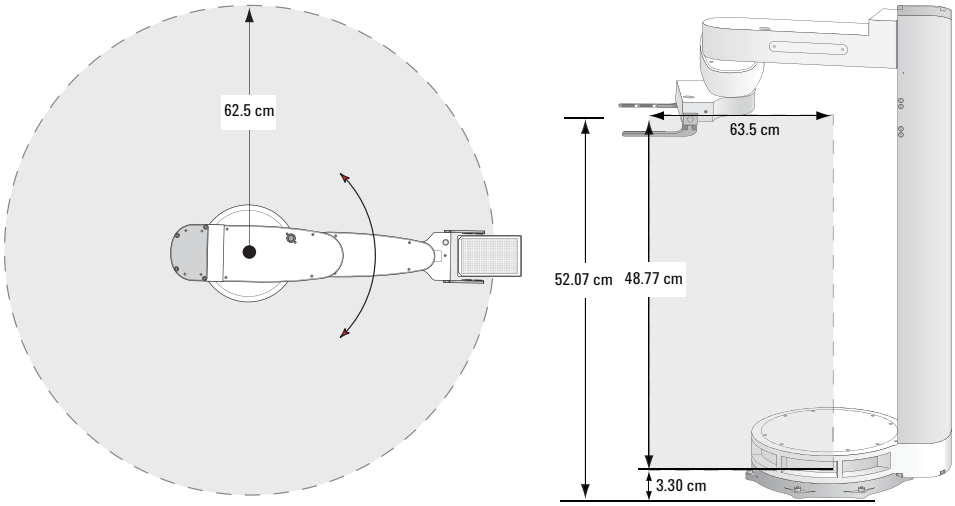
For information about...	See...
Robot reach and workspace	“Reach and workspace” on page 18
Axis and gripper specifications	“Axis and gripper specifications” on page 21
Performance specifications	“Performance specifications” on page 23
Mounting specifications	“Mounting specifications” on page 24
Electrical requirements	“Electrical requirements” on page 27

For information about...	See...
Computer requirements	“Computer requirements” on page 29
Environmental requirements	“Environmental requirements” on page 28

Reach and workspace

Robot reach

Figure Direct Drive Robot radial reach at 0° wrist angle and vertical reach.



Maximum reach	Value
Radial reach (based on wrist angle)	Center of rotation to center of microplate 0–15°: 63.5 cm (25.0 in) 30°: 61.5 cm (24.2 in) 45°: 58.2 cm (22.9 in) 60°: 54.1 cm (21.3 in) 90°: 45.3 cm (17.8 in)
Vertical reach (from attachment surface)	Minimum: 3.30 cm (1.30 in) Maximum: 52.07 cm (20.50 in) Highest teachpoint with 0 offset: 50.39 cm (19.84 in)

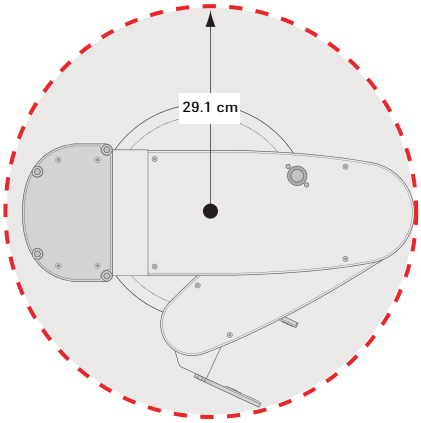
Safe zone

The safe zone is the cylindrical region within which the Direct Drive Robot is allowed to move without colliding with external devices. In general, the robot moves into the safe zone to change its arm orientation, rotate its wrist, or for other purposes after it completes a Move to, Pick from, Place to, or Transfer command.

CAUTION Do not set teachpoints within the safe zone.

The following diagram shows the top view of the robot safe zone. It is the cylindrical region within the dotted line. The radius of the cylinder, measured from the center of the base, is 29.1 cm (11.4 in).

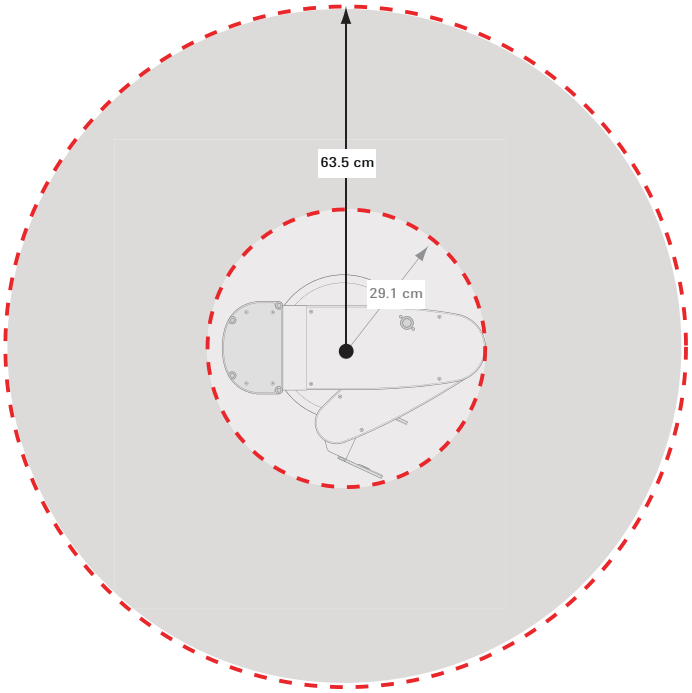
Figure Direct Drive Robot safe zone



Teachpoint zone

The teachpoint zone is the region within which you can set teachpoints. The following diagram shows the top view of the teachpoint zone. The outermost dotted line shows the robot's maximum reach. The cylindrical region within the inner circle is the the safe zone. The teachpoint zone is between the two boundaries.

Figure Direct Drive Robot teachpoint zone

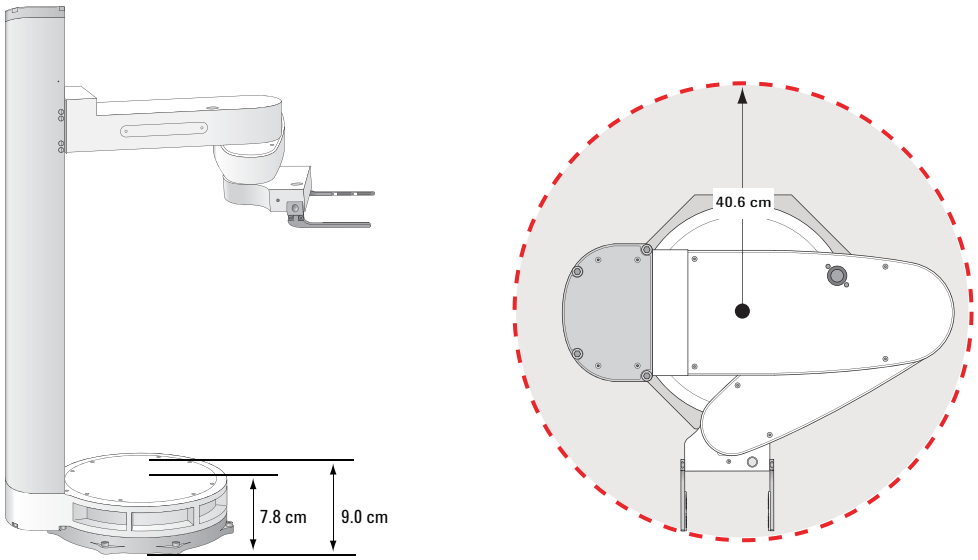


Caution zone

The caution zone is the thin, doughnut-shaped region surrounding the robot waist and base. When the robot moves to and from a teachpoint within this zone, the back of its wrist might bump into the waist. To avoid such collisions, you can change the position of the teachpoint such that the robot will approach or retract from the location using an alternate angle.

The following diagram shows the caution zone. The height of the region is measured from the attachment surface to 1.2 cm above the top surface of the waist. The radius of the region is 40.6 cm (16 in). These measurements assume the use of the standard grippers and teaching jig.

Figure Direct Drive Robot caution zone



Related information

For information about...	See...
Robot dimensions	“Physical dimensions” on page 14
Axis and gripper specifications	“Axis and gripper specifications” on page 21
Performance specifications	“Performance specifications” on page 23
Mounting specifications	“Mounting specifications” on page 24
Electrical requirements	“Electrical requirements” on page 27
Computer requirements	“Computer requirements” on page 29
Environmental requirements	“Environmental requirements” on page 28

Axis and gripper specifications

Waist	
Travel	Infinite rotation
Maximum rated torque	362.55 Nm (267.41 lb-ft)
Maximum continuous stall torque at temperature rise 75.000 °C	25.74 Nm (18.99 lb-ft)
Maximum velocity	400°/s
Elbow	
Travel	Infinite rotation
Maximum rated torque	36.68 Nm (5193.73 oz-in)
Maximum continuous stall torque at temperature rise 75.000 °C	2.86 Nm (404.61 oz-in)
Maximum velocity	425°/s
Wrist	
Travel	Infinite rotation
Maximum rated torque	14.23 Nm (2014.90 oz-in)
Maximum continuous stall torque at temperature rise 75.000 °C	0.58 Nm (81.73 oz-in)
Maximum velocity	540°/s
Z-axis	
Travel	3.30–52.07 cm (1.30–20.50 in) from the attachment surface
Maximum rated force	420 N (94.4 lb)
Maximum continuous stall force at coil temperature 100 °C	120.2 N (27.0 lb)
Maximum velocity	1000 mm/s
Gripper	
Travel	Closed: 76.5 mm Open: 136 mm
Force	0–2 kg

Related information

For information about...	See...
Robot dimensions	“Physical dimensions” on page 14
Reach and workspace	“Reach and workspace” on page 18
Performance specifications	“Performance specifications” on page 23
Mounting specifications	“Mounting specifications” on page 24
Electrical requirements	“Electrical requirements” on page 27
Computer requirements	“Computer requirements” on page 29
Environmental requirements	“Environmental requirements” on page 28

Performance specifications

Performance	
Labware width	Minimum: 80 mm (portrait) Maximum: 133 mm (landscape)
Payload	SBS microplates Full speed: 200 g Maximum: 500 g
Repeatability	x, y, z: ±0.1 mm Phi: ±0.02°
Transfer time	Pick-and-place: < 4 s average

Related information

For information about...	See...
Robot dimensions	“Physical dimensions” on page 14
Reach and workspace	“Reach and workspace” on page 18
Axis and griper specifications	“Axis and gripper specifications” on page 21
Mounting specifications	“Mounting specifications” on page 24
Electrical requirements	“Electrical requirements” on page 27
Computer requirements	“Computer requirements” on page 29
Environmental requirements	“Environmental requirements” on page 28

Mounting specifications

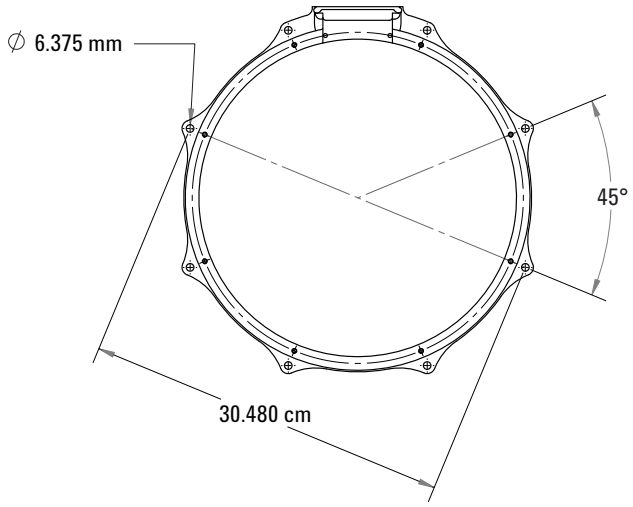
Attachment surface

The Direct Drive Robot must be installed vertically on a flat stiff surface that is stable. A deformable and non-stable support will greatly reduce the robot's speed and accuracy, and possibly cause errors.

Mounting bolts

Eight bolts are required to hold the Direct Drive Robot to the attachment surface. The following diagram shows the base of the robot and the spacing of the holes for the bolts.

Figure Direct Drive Robot mounting base

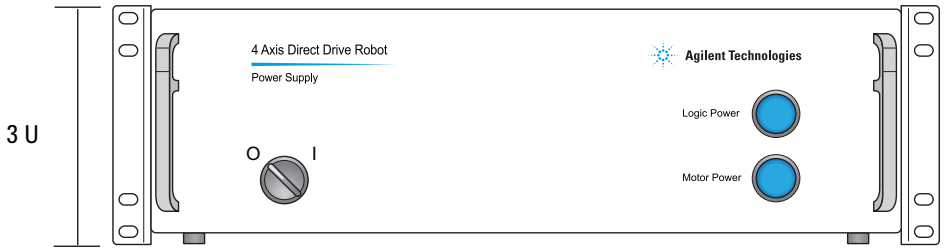


Mounting requirement	Measurement
Bolt hole diameter	6.375 mm (0.251 in), through the base
Bolt type	M6
Number of bolts	8
Bolt-circle diameter	30.480 cm (12.000 in)
Mounting base – height	0.952 cm (0.375 in)

Power supply

The power supply has two mounting brackets as the following diagram shows. The brackets are 3 rack units (or 3U) in overall height, and permit the power supply to be mounted in a standard 19-inch rack.

Figure Direct Drive Robot power supply (front view)



CAUTION Air vents are on the left and right sides of the power supply. Be sure to provide at least 1.3 cm (0.5 in) of clearance on both sides.

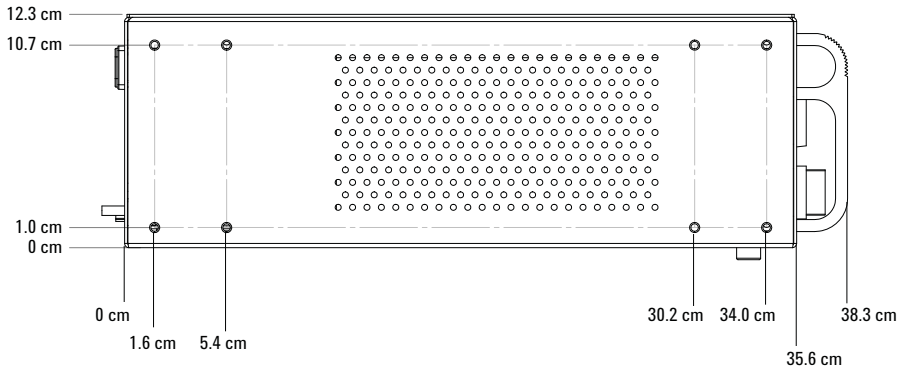
IMPORTANT Because of its weight, Agilent Technologies recommends that you mount the power supply at the bottom of the rack. Mounting the power supply at the bottom of the rack also facilitates service access.

IMPORTANT If you must mount power supply G5411-60005 higher in a rack, be sure to use additional brackets at the back end to support the weight of the power supply. To order the support brackets, contact Automation Solutions Customer Service.

To mount the power supply vertically, turn the power supply onto its left side only (power switch is on the bottom, indicator lights are on top). When mounting the power supply vertically, you can remove the supplied mounting brackets and install desired mounting components. To order vertical mounting brackets, contact Automation Solutions Customer Service.

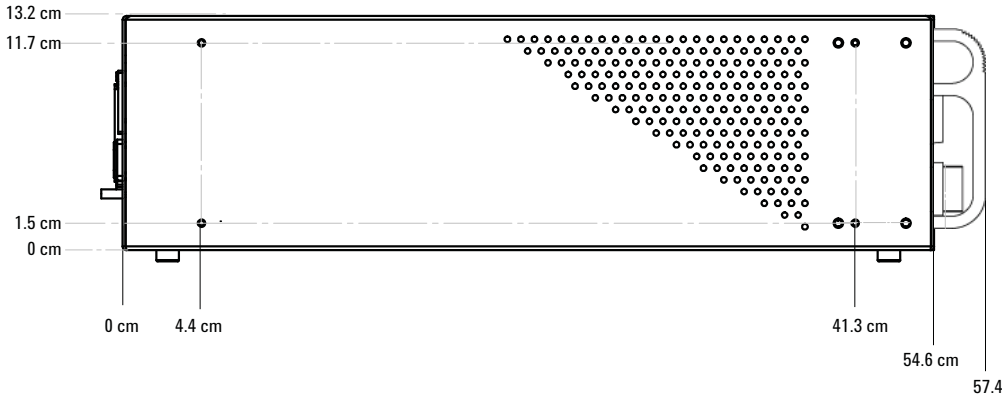
The following diagram shows the specifications for the left side of power supply G5411-60010. The holes are M4 x 0.7 screw thread.

Figure Direct Drive Robot power supply (G5411-60010) left side specifications



The following diagram shows the specifications for the left side of power supply G5411-60005. The holes are M4 x 0.7 screw thread.

Figure Direct Drive Robot power supply (G5411-60005) left side specifications



CAUTION Do not block the air vent. Be sure to provide at least 1.3 cm (0.5 in) of clearance on the bottom when mounting the power supply vertically.

Related information

For information about...	See...
Robot dimensions	“Physical dimensions” on page 14
Reach and workspace	“Reach and workspace” on page 18
Axis and griper specifications	“Axis and gripper specifications” on page 21
Performance specifications	“Performance specifications” on page 23
Electrical requirements	“Electrical requirements” on page 27
Computer requirements	“Computer requirements” on page 29
Environmental requirements	“Environmental requirements” on page 28

Electrical requirements

Requirement	Value
Voltage	100–240 VAC
Frequency	50/60 Hz
Current	10 A
Power consumption	200 W typical
Fuses	• *Mains.* 2 × 10 A, 250 V, time delay • *Logic power/switch.* 2 A, 250 V, time delay • *Robot.* 4 A, 250 V, time delay • *Emergency stop pendant.* 0.8 A, 250 V, time delay (only in model G5411-60005)
Chassis plug	IEC 60320 C14

Related information

For information about...	See...
Robot dimensions	“Physical dimensions” on page 14
Reach and workspace	“Reach and workspace” on page 18
Axis and griper specifications	“Axis and gripper specifications” on page 21
Performance specifications	“Performance specifications” on page 23
Mounting specifications	“Mounting specifications” on page 24
Computer requirements	“Computer requirements” on page 29
Environmental requirements	“Environmental requirements” on page 28

Environmental requirements

IMPORTANT The Direct Drive Robot must operate within the temperature and humidity specifications stated in the following table.

Operating	Recommended range
Temperature	4–40 °C
Humidity	10–90% RH, non-condensing
Storage (non-operating)	**Recommended range**
Temperature	-20–50 °C
Humidity	0–90% RH, non-condensing

Related information

For information about...	See...
Robot dimensions	“Physical dimensions” on page 14
Reach and workspace	“Reach and workspace” on page 18
Axis and griper specifications	“Axis and gripper specifications” on page 21
Performance specifications	“Performance specifications” on page 23
Mounting specifications	“Mounting specifications” on page 24
Electrical requirements	“Electrical requirements” on page 27
Computer requirements	“Computer requirements” on page 29

Computer requirements

Computer requirements

If your organization uses a computer other than one configured by Agilent Technologies, make sure the computer meets the following minimum requirements:

- Computer system
  - Microsoft Windows XP with Service Pack 3,
    Microsoft Windows Vista with Service Pack 2, or
    Microsoft Windows 7
  - 2 GHz or faster 32-bit (x86) processor, multicore preferred
  - 2 GB system memory
  - 40 GB hard drive capacity with 10 GB free space
  - 1280 x 1024 pixel screen resolution
  - Microsoft Internet Explorer 6.0 or Mozilla Firefox 1.0 with JavaScript enabled (required for using the context-sensitive help and knowledge base)
  - A PDF viewer, such as Adobe Reader (required for opening the user guide PDF files)
- Dedicated 10BaseT or faster Ethernet card (two network cards if connecting to your local area network)

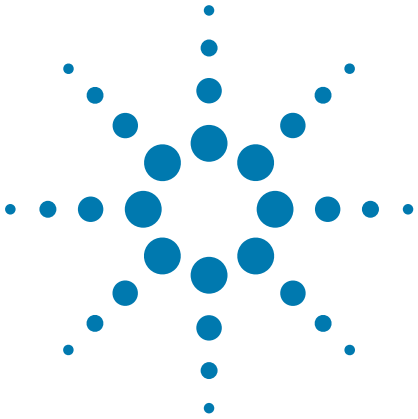
Controlling software

VWorks installer 10.0.0.8.21.2009 or later is required.

To facilitate the setup process, a software installation CD is supplied. You can use the CD to install the necessary software and setup configurations.

Related information

For information about...	See...
Software installation	*VWorks Automation Control Setup Guide*
How to set up the VWorks software for operation	*VWorks Automation Control Setup Guide*
How to write protocols	*VWorks Automation Control User Guide*



3 Unpacking and installing the Direct Drive Robot

This chapter contains the following topics:

- "Installation and setup workflow" on page 32
- "Packing workflow" on page 33
- "Unpacking and packing the robot" on page 34
- "Removing and installing the shipping brace" on page 39
- "Installing and removing the robot" on page 42
- "Turning on and turning off the robot" on page 46

Installation and setup workflow

Workflow

The following table presents the steps for unpacking, installing, and setting up the Direct Drive Robot for operation.

Step	For this task...	See...
1	Unpack the robot.	"Unpacking and packing the robot" on page 34
2	Remove the shipping brace.	"Removing and installing the shipping brace" on page 39
3	Install the robot.	"Installing and removing the robot" on page 42
4	Turning on the robot.	"Installing and removing the robot" on page 42
5	Install the VWorks software.	*VWorks Automation Control Setup Guide*

Related information

For information about...	See...
Setting teachpoints	"Setting teachpoints" on page 77
Packing the robot	"Packing workflow" on page 33

Packing workflow

Workflow

The following table presents the steps for removing and packing the Direct Drive Robot for storage or shipping.

Step	For this task...	See...
1	Remove the robot from the attachment surface.	"Removing the Direct Drive Robot" on page 44
2	Install the shipping brace.	"Installing the shipping brace" on page 40
3	Pack the robot and power supply in their shipping containers.	"Packing the robot in the shipping crate" on page 36

Related information

For information about...	See...
Unpacking and installing the robot	"Installation and setup workflow" on page 32
Setting teachpoints	"Setting teachpoints" on page 77

Unpacking and packing the robot

Shipping containers

The Direct Drive Robot ships in the following containers:

- ***Direct Drive Robot crate***. Contains the Direct Drive Robot and utility kit.
- ***Power supply box***. Contains the robot power supply.

Unpacking the crate

Before you start

Verify the following:

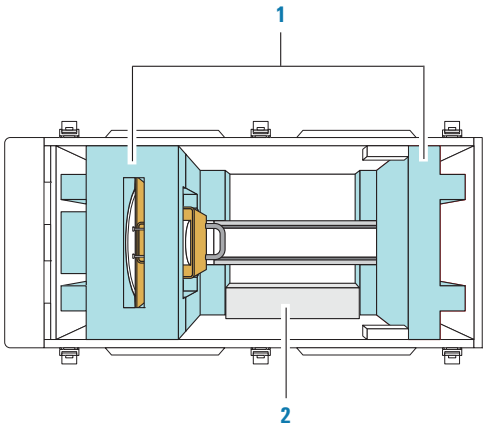
1. ***Site specifications.*** Make sure the installation site meets the requirements specified in the *Direct Drive Robot Site Preparation and Safety Guide* or "Specifications and site requirements" on page 13.
2. ***Personnel requirements.*** Make sure two people are available to lift and move the robot from the crate.

Procedure

IMPORTANT Save the packaging materials in case you need to move or ship the Direct Drive Robot.

To unpack the Direct Drive Robot crate:

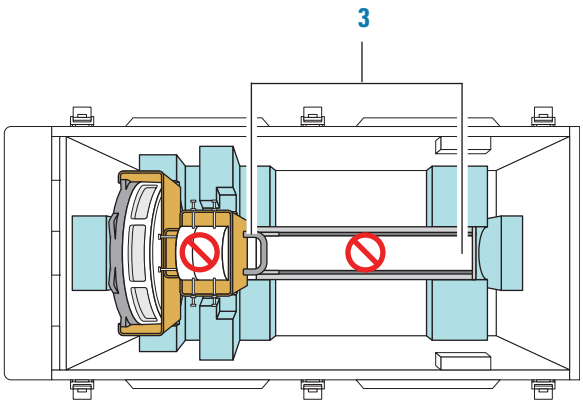
1. Open the latches and remove the top of the crate.
2. Remove the two foam blocks on top of the robot (1). Remove the cardboard box (2).



3. With one person holding the handle on the shipping brace and another person supporting the robot under the mast, carefully lift the robot out of the crate (3).

CAUTION Never lift the robot from its arm.

CAUTION Do not press down on the plate on the front of the mast.



4 Remove the robot from the plastic wrap and place the robot on a flat, stable surface where it will be possible for you to access all sides of the robot.

Inspecting the contents

IMPORTANT Inspect all items for completeness and potential shipping damage. If an item is defective on arrival, contact the Automation Solutions Business Center at 1.800.227.9770 as soon as possible.

After you unpack the robot crate, cardboard box, and power supply box, make sure you have the following:

Part name	Part number
Direct Drive Robot (in shipping brace):	
Cable connection on the side, or	23083-211
Cable connection on the bottom	23083-212
Power supply:	
Fuses on the back side, or	G5411-60010
Fuses inside	G5411-60005
2-mm hex wrench	G5550-04237
4-mm hex wrench	G5550-04234
5-mm hex wrench	G5550-01523
M6 mounting bolts (8)	G5550-02705
Power supply mounting	
Pan-head Phillips machine screws (4)	G5550-09078
M05 split lock washer (4)	G5550-02453
M05 flat washer (4)	G5550-02439
Teaching jig	G5550-23357

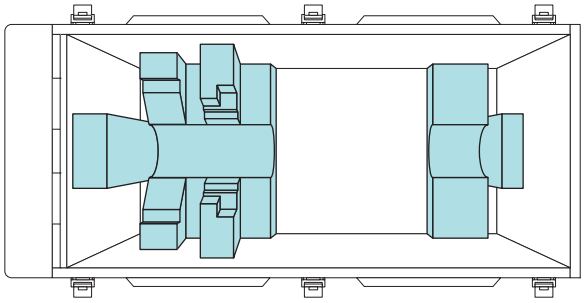
Part name	Part number
Regrip station assembly:	
Regrip station	G5550-20020
M6 mounting screw	G5550-02697
Gripper pad replacement parts:	
Gripper pads (2)	G5550-23287
Cap screws (6)	5023-1658
Star-head wrench	5023-1659
Threadlocking solution	5188-8370
Power cable	Request by country
Robot cable	G5550-23704
Emergency stop pendant and cable	16971-001
Ethernet cable	G5550-09363
VWorks software CD:	
Benchtop license, or	08330-402
System license	08330-403
Direct Drive Robot Site Preparation and Safety Guide	G5430-90001

Packing the robot in the shipping crate

Procedure

To pack the robot in its shipping crate:

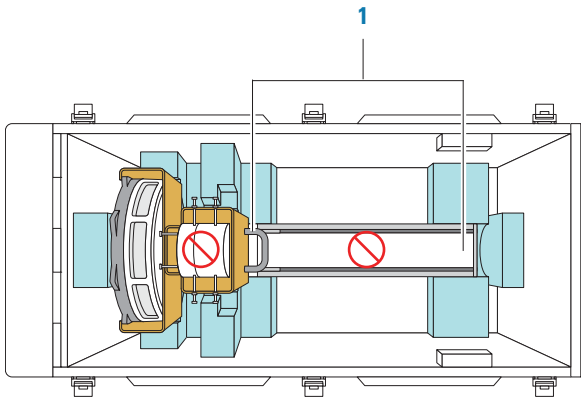
1 Insert the two bottom foam blocks in the crate as shown.



2 While holding the handle on the shipping brace and supporting the robot under the mast (1), carefully lift and place the robot in the crate as shown.

CAUTION Never lift the robot from its arm.

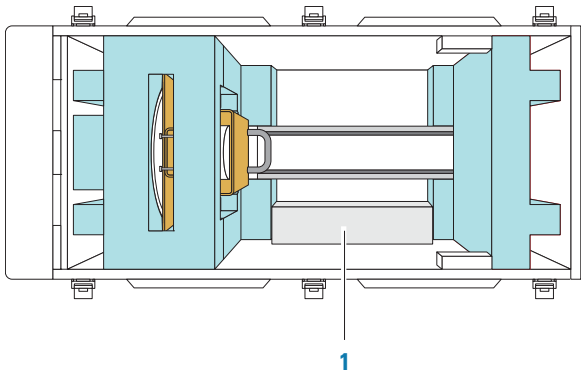
CAUTION Do not press down on the plate on the front of the mast.



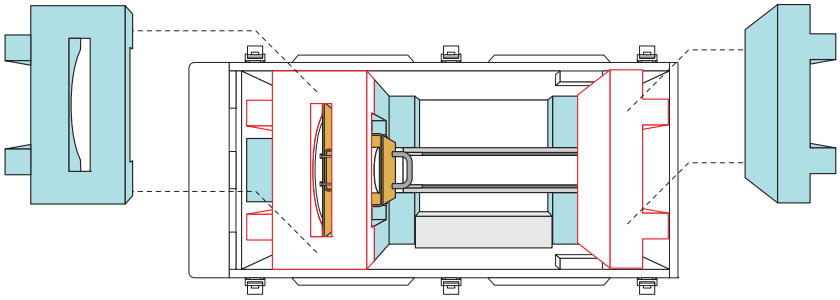
3 Pack the following items in the small cardboard box:

- Robot cable
- Power cable
- Emergency stop pendant and cable
- Ethernet cable
- M6 mounting bolts (8)
- Teaching jig
- Regrip station and M4 mounting screw
- Gripper pad replacement kit (spare pair of gripper pads, 6 cap screws, star-head wrench, and thread-locking solution)
- Power supply mounting washers and screws
- 2-mm hex wrench
- 4-mm hex wrench
- 5-mm hex wrench
- VWorks software CD
- *Direct Drive Robot Site Preparation and Safety Guide*

4 Insert the cardboard box in the crate as shown (1).



5 Insert the two remaining foam blocks in the crate.



6 Place the crate cover on the crate and close the latches.

7 Pack the power supply and power cable in the power supply box.

Related information

For information about...	See...
Removing the shipping brace	"Removing the shipping brace" on page 39
Installing the robot	"Installing the robot" on page 42
Turning on the robot	"Turning on the Direct Drive Robot" on page 46
Installing the VWorks software	*VWorks Automation Control Setup Guide*
Adding the robot to a device file	"Adding and deleting Direct Drive Robots in the device file" on page 53
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting teachpoints	"Setting teachpoints" on page 77
Turning off the robot	"Turning off the Direct Drive Robot" on page 46
Installing the shipping brace	"Installing the shipping brace" on page 40

Removing and installing the shipping brace

Required tools

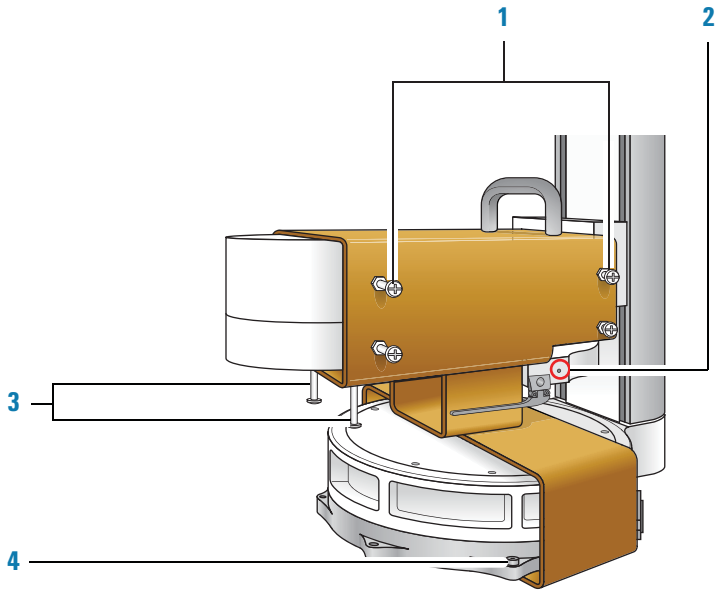
Before you start, make sure you have the following tools:

- 2-mm hex wrench
- 5-mm hex wrench

Removing the shipping brace

IMPORTANT Save the shipping brace and the screws in case you need to move or ship the robot.

To remove the shipping brace:



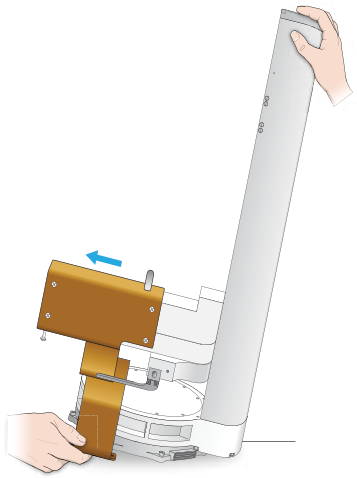
1 Loosen the four nylon screws on each side of the brace by hand.

2 Using the 2-mm hex wrench, turn the gripper lead screw to open the grippers as wide as possible.

3 Loosen the two nylon screws below the robot arm.

4 Using the 5-mm hex wrench, unscrew and remove the four metal screws that are holding the shipping brace to the robot base.

5 Tilt the robot at a slight angle as shown.



6 While holding the brace by the handle, carefully slide the brace away from the robot.

Installing the shipping brace

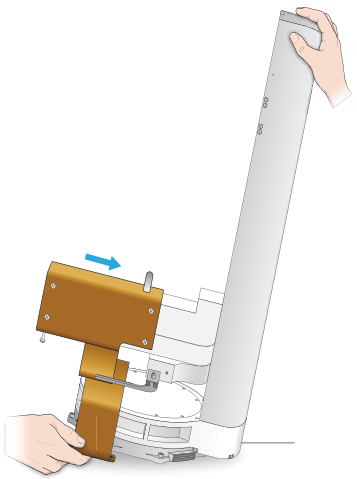
In addition to the items listed in "Required tools" on page 39, make sure you have the following:

- Shipping brace
- 10 nylon screws
- Four 5-mm metal screws with washers

CAUTION Make sure you have followed the instructions in "Removing the Direct Drive Robot" on page 44 before installing the shipping brace.

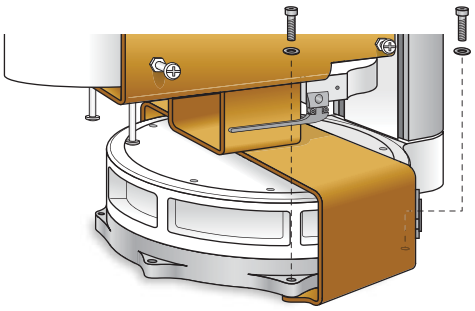
To install the shipping brace:

1 Have another person tilt and hold the robot at a slight angle toward the mast. Make sure the connector at the base is not aligned with the mast.

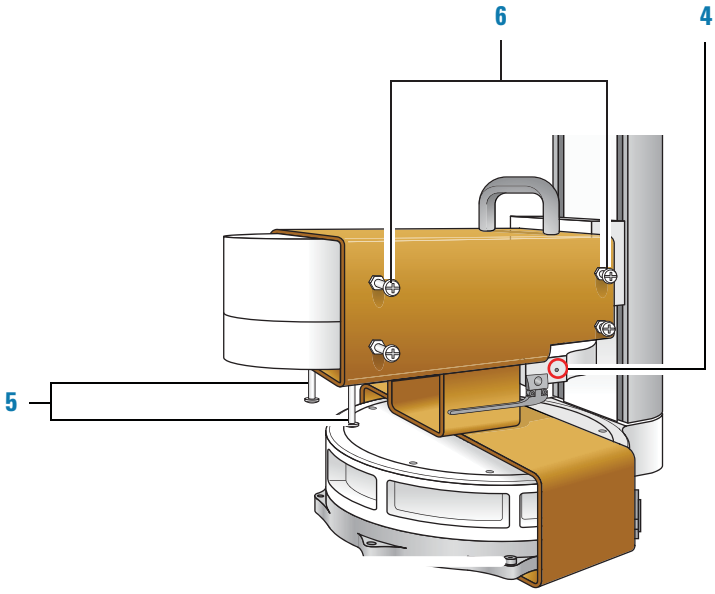


2 While holding the brace by the handle and supporting the weight of the brace at the opposite end, slowly and carefully slide the brace onto the robot. The tucked robot arm fits in the brace's upper sleeve, and the robot base fits in the brace's lower sleeve.

3 Insert the four metal screws with washers in the mounting holes at the robot base, and use the 5-mm hex wrench to tighten the screws. The screws should hold the shipping brace to the robot base.



4 Using the 2-mm hex wrench, turn the gripper lead screw to close the robot grippers until they are secured against the brace.



5 Tighten the two nylon screws under the robot arm.

6 Tighten the eight nylon screws on both sides of the brace.

Related information

For information about...	See...
Installing the robot	"Installing the robot" on page 42
Turning on the robot	"Turning on the Direct Drive Robot" on page 46

For information about...	See...
Installing the VWorks software	*VWorks Automation Control Setup Guide*
Adding the robot to a device file	"Adding and deleting Direct Drive Robots in the device file" on page 53
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting teachpoints	"Setting teachpoints" on page 77
Packing the robot and power supply	"Packing the robot in the shipping crate" on page 36

Installing and removing the robot

Materials and tools

Make sure you have the following materials and tools:

- 5-mm hex wrench (G5550-01523)
- M6 mounting bolts, 8 (G5550-02705)
- #2 Phillips screw driver (not supplied)
- 18-8 SS pan-head Phillips machine screws, 4 (G5550- 09078)
- M05 split lock washers, 4 (G5550- 02453)
- M05 flat washers, 4 (G5550- 02439)
- 2.5-mm hex wrench (not supplied)
- Power cord (part number varies by country)
- Robot cable (G5550- 23704)
- Ethernet cable (G5550- 09363)
- Emergency stop pendant and cable (16971- 001)

Installing the robot

When you install the robot, you first attach the robot to a stable and flat surface, mount the power supply (if desired), then connect the power, communication, and emergency stop pendant cables.

Attaching the robot

To attach the robot:

1 Position the robot on the attachment surface so that the base aligns over the mounting holes.

If the robot-cable connector is on the side of the base (robot 23083-211), make sure the connector is positioned such that the distance to the power supply will be minimal and that the robot cable will be clear of other devices on the attachment surface.

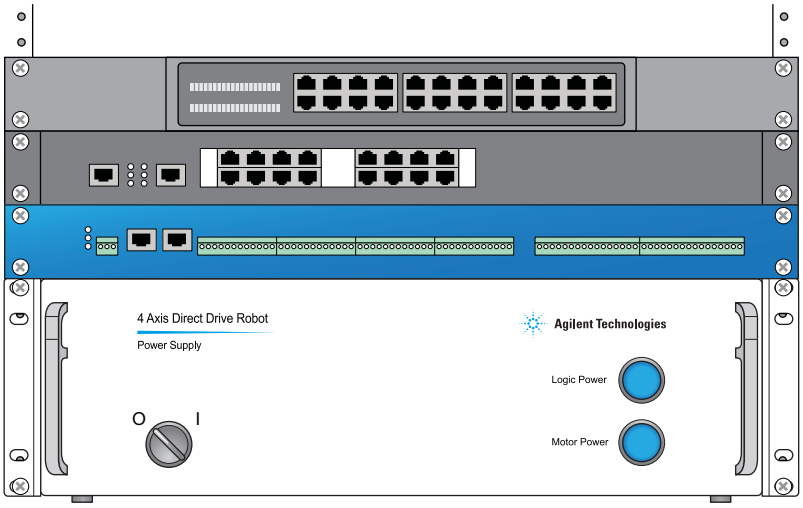
If the robot cable connector is on the bottom of the base (robot 23083-212), make sure the connector will be accessible from below the attachment surface.

2 Insert the M6 bolts in the eight mounting holes and use the supplied 5-mm wrench to tighten the bolts until snug.

Note: For custom tables, longer bolts and nuts and washers might be required.

Mounting the power supply

The power supply has two mounting brackets so that you can mount it on a standard 19-inch rack. The following diagram shows an example of how you can mount the power supply in a system.



IMPORTANT Because of its weight, Agilent Technologies recommends that you mount the power supply at the bottom of the rack. Mounting the power supply on the bottom of the rack also facilitates service access.

To mount the power supply on a standard mounting rack:

1 Insert each pan-head screw through a split-lock washer first, and then through a flat washer.

2 Align two holes in each mounting bracket with two holes in the rack.

3 Insert the screw-washer assembly into each hole and tighten using the screwdriver.

Alternatively, you can turn the power supply onto its left side and mount the power supply vertically. To mount the power supply vertically, you can remove the supplied mounting brackets and use your own mounting components. For vertical mounting specifications, see "Mounting specifications" on page 24.

Connecting the cables

To connect the cables:

1 Use the supplied power cord to connect the robot power supply to the power source.

2 Use the supplied robot cable to connect the robot to the power supply. The connector on the robot is on the side of or below the robot base.

3 Use the supplied Ethernet cable to connect the robot power supply to the controlling computer. Connect the computer to the lab's wide area network.

4 Connect the free end of the emergency stop pendant cable to the **ROBOT DISABLE** connector on the robot power supply.

Figure Power supply G5411-60010

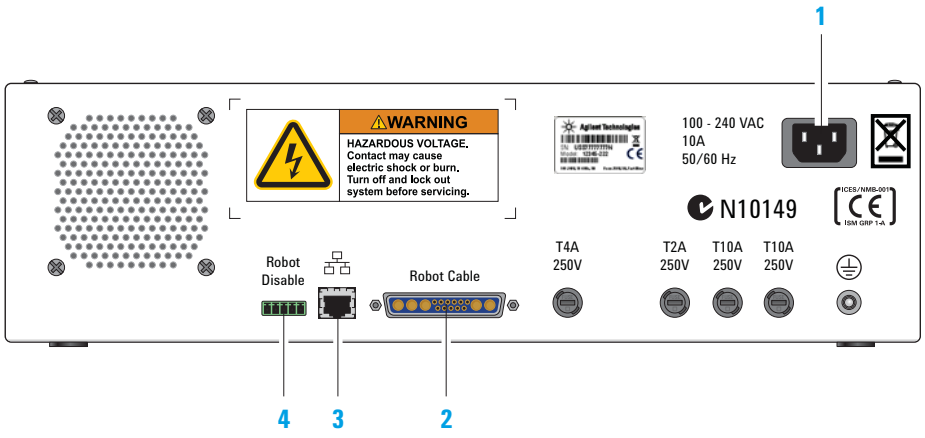
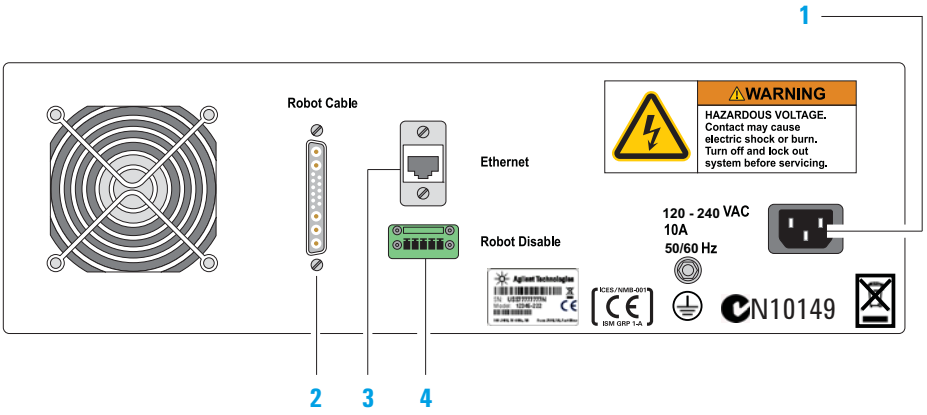


Figure Power supply G5411-60005



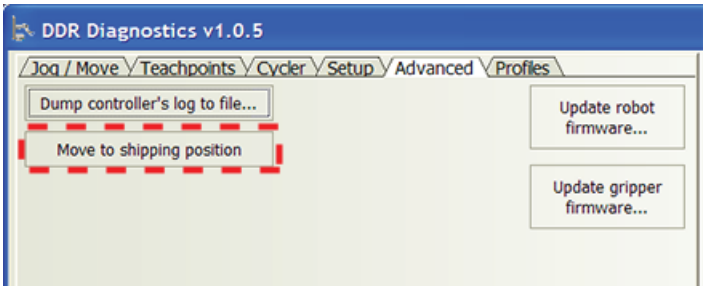
Removing the Direct Drive Robot

Before you start

Before you remove the robot from its attachment surface:

1 Move the robot arm to the shipping position. In **DDR Diagnostics,** click **Move to shipping position** in the **Advanced** tab. The robot tucks its forearm and grippers under its bicep. The tucked robot arm lowers along the mast to its packaging height.

WARNING **Keep out of the system while the robot is moving.**



2 Turn off the system and the robot. For instructions, see the system user documentation and "Turning off the Direct Drive Robot" on page 46.

Procedure

To disconnect the robot:

Disconnect and remove the following:

- Power cable
- Robot cable
- Ethernet cable
- Emergency stop pendant cable

To detach the robot:

1 Using the supplied 5-mm hex wrench, unscrew the eight M6 bolts that are holding the robot to the attachment surface.

2 Place the robot on a flat, stable surface where it will be possible for you to access all sides of the robot.

Removing the power supply

To remove the power supply from the mounting rack:

1 Using the Phillips screwdriver, unscrew the four screws that are holding the power supply to the mounting rack.

2 Save the screws and washers for reinstallation.

Related information

For information about...	See...
Turning on the robot	"Turning on the Direct Drive Robot" on page 46
Installing the VWorks software	*VWorks Automation Control Setup Guide*
Adding the robot to a device file	"Adding and deleting Direct Drive Robots in the device file" on page 53
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting teachpoints	"Setting teachpoints" on page 77

For information about...	See...
Turning off the robot	"Turning off the Direct Drive Robot" on page 46
Installing the shipping brace	"Installing the shipping brace" on page 40
Packing the robot and power supply	"Packing the robot in the shipping crate" on page 36

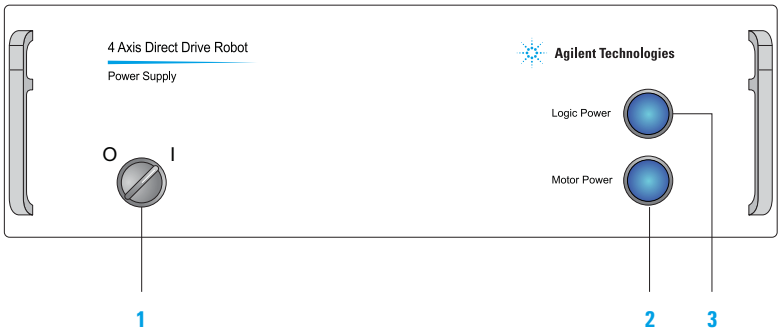
Turning on and turning off the robot

Turning on the Direct Drive Robot

WARNING **The robot will move its arm during the startup process. Keep out of the system while the robot is starting up.**

To turn on the robot:

At the front of the robot power supply, turn the power switch clockwise to the on (**I**) position (1).



If the robot turns on successfully:

- The Logic Power light (2) and the Motor Power light (3) both turn on. If one or both lights do not turn on, see "Troubleshooting hardware problems" on page 203.
- The blue light on the robot hand turns on for a few seconds, and then turns off.
- The robot arm moves slightly, and then moves to its home position.

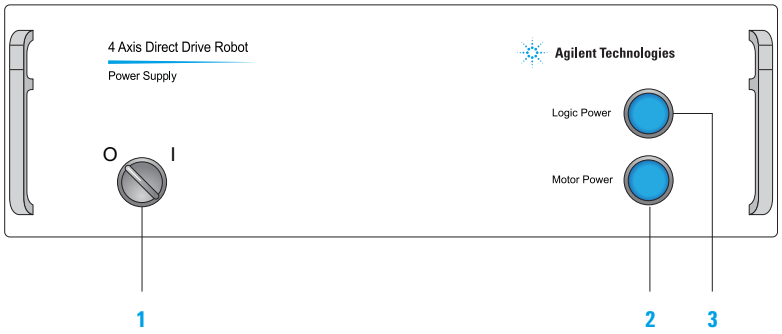
The entire startup process takes approximately 3 minutes.

Turning off the Direct Drive Robot

IMPORTANT If you will be packing the robot for storage or shipment, you must first move the robot arm to its packing position before turning off its power. See "Removing the Direct Drive Robot" on page 44 for instructions.

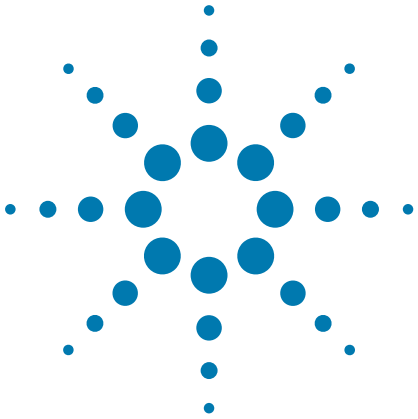
To turn off the robot:

At the front of the robot power supply, turn the power switch counterclockwise to the off (**O**) position (1). The Logic Power (2) and Motor Power lights (3) turn off.



Related information

For information about...	See...
Installing the VWorks software	*VWorks Automation Control Setup Guide*
Adding the robot to a device file	"Adding and deleting Direct Drive Robots in the device file" on page 53
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting teachpoints	"Setting teachpoints" on page 77
Removing the robot from the attachment surface	"Removing the Direct Drive Robot" on page 44
Installing the shipping brace	"Installing the shipping brace" on page 40
Packing the robot and power supply	"Packing the robot in the shipping crate" on page 36



4 Setting up the Direct Drive Robot

This chapter contains the following topics:

- "Setup workflow" on page 50
- "Creating a device file" on page 51
- "Adding and deleting Direct Drive Robots in the device file" on page 53
- "Creating Direct Drive Robot profiles" on page 56
- "Setting up robot communication" on page 58
- "Setting miscellaneous parameters in the profile" on page 60
- "Selecting a teachpoint file" on page 62
- "Saving the profile" on page 64
- "Initializing the profile" on page 65
- "Editing and managing profiles" on page 67
- "Specifying the table dimensions and robot position" on page 69

Setup workflow

About this topic

This topic presents the workflow for setting up the Direct Drive Robot for operation.

WARNING **Only administrators and experienced personnel should perform the procedures in this chapter.**

Workflow

The following table presents the steps for setting up the Direct Drive Robot. After setting up the Direct Drive Robot for the first time, you will not likely change any of the settings in the procedure.

Step	For this task...	See...
1	Create a device file.	“Creating a device file” on page 51
2	Add the Direct Drive Robot in the device file.	“Adding and deleting Direct Drive Robots in the device file” on page 53.
3	Create a profile for the Direct Drive Robot.	“Creating Direct Drive Robot profiles” on page 56
4	Set up robot communication.	“Setting up robot communication” on page 58
5	Set miscellaneous parameters in the profile.	“Setting miscellaneous parameters in the profile” on page 60
6	Select a teachpoint file.	“Selecting a teachpoint file” on page 62
7	Save the profile.	“Saving the profile” on page 64
8	Initialize the profile.	“Initializing the profile” on page 65
9	Specify table dimensions and robot position	“Specifying the table dimensions and robot position” on page 69

Related information

For information about...	See...
Teachpoint files	“Teachpoint files” on page 88
Setting teachpoints	“Setting teachpoints” on page 77

Creating a device file

About this topic

This topic explains how to create a device file, and add and delete the Direct Drive Robot in the device file.

Devices and device file defined

What is a device?

A device is an item in your lab automation system that has an entry in the VWorks software device file. A device can be a robot, an instrument, or a location in the system that can hold a piece of labware. The following are some examples of devices:

- Direct Drive Robot
- PlateLoc Thermal Microplate Sealer
- Microplate Labeler
- Vertical Pipetting Station shelf
- Platepad
- All third-party devices integrated in the lab automation system

What is a device file?

To communicate with and to control the robot and integrated devices, the VWorks software uses a device file that contains the following information:

- List of devices the software will communicate with and control
- System-related configuration information of each device (for example, approach height, barcode access, and so on)
- Profile of each device (communication method, unique device configuration information)

You provide the device information in the VWorks software. The device information is stored in a device (.dev) file that is located in a folder you specify when saving the file.

For detailed information about device files and associations with profiles, teachpoint files, and other VWorks components, see the *VWorks Automation Control User Guide*.

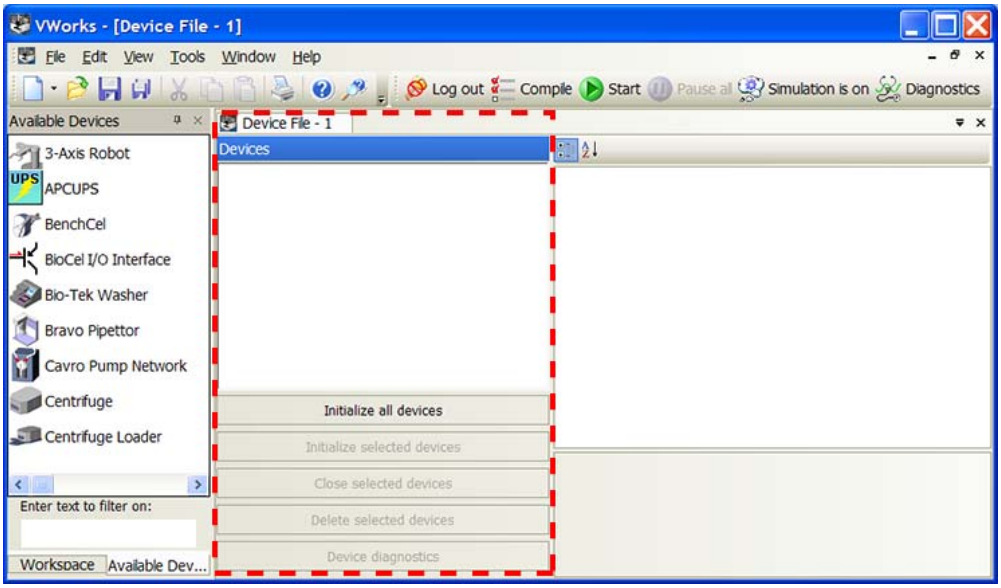
Procedure

If you are setting up the Direct Drive Robot for the first time, you need to create a new device file, and then add the Direct Drive Robot robot and integrated devices to this file.

Before you create a device file, start the VWorks software and log in. See the *VWorks Automation Control User Guide* for instructions.

To create a new device file:

1 In the **VWorks** window, select **File > New > Device.** A Device File tab appears.



2 Select **File > Save** to save the device file. The file name appears in the Device File tab.

Related information

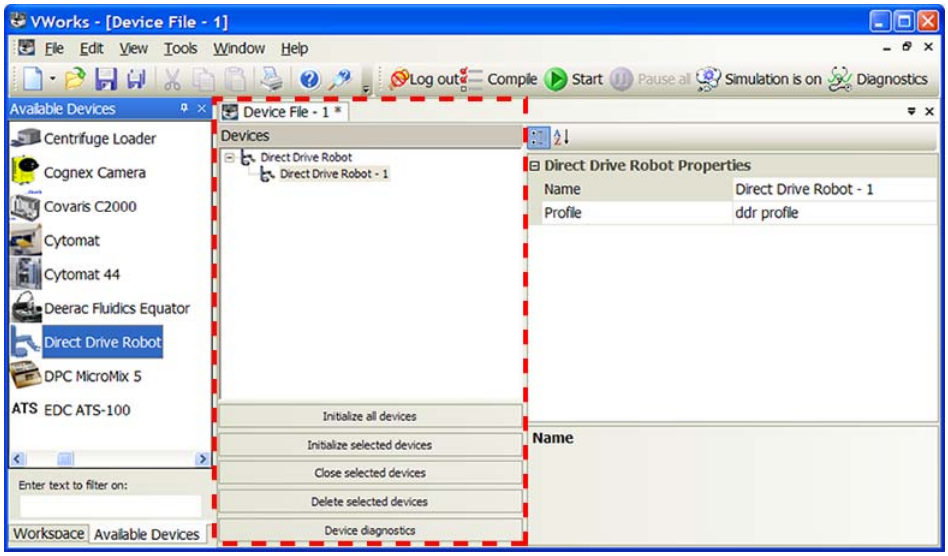
For information about...	See...
VWorks software	• *VWorks Automation Control Setup Guide* • *VWorks Automation Control User Guide*
Adding the Direct Drive Robot in the device file	"Adding and deleting Direct Drive Robots in the device file" on page 53
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting teachpoints	"Setting teachpoints" on page 77

Adding and deleting Direct Drive Robots in the device file

Adding Direct Drive Robots in the device file

To add a Direct Drive Robot in the device file:

1 In the **Available Devices** area, double-click the Direct Drive Robot device icon. Alternatively, you can drag the icon from the **Available Devices** area into the **Device File** area.



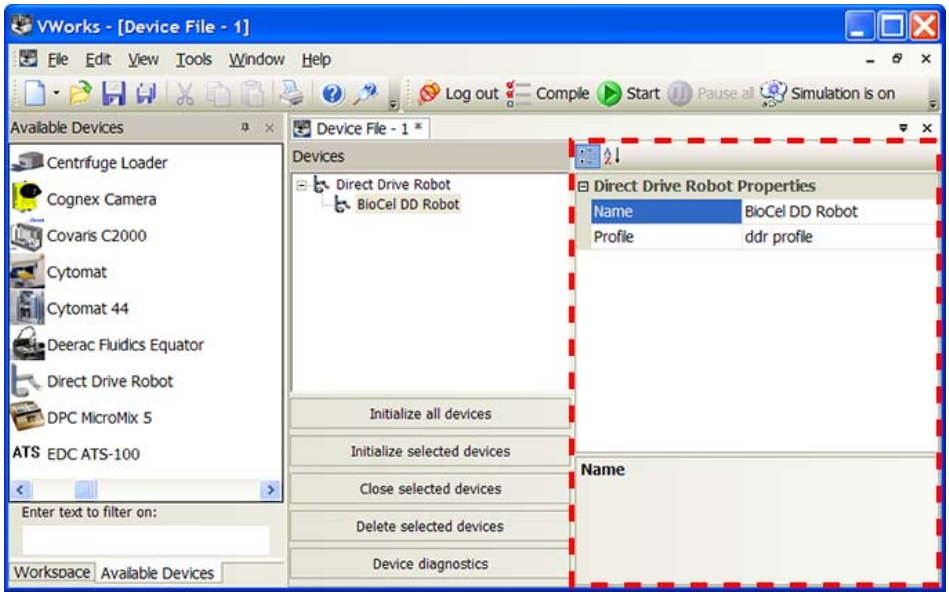
Notice that the first Direct Drive Robot device is labeled Direct Drive Robot-1. If you add another Direct Drive Robot device, it will appear as Direct Drive Robot-2.

If you do not see the Direct Drive Robot in the **Available Devices** list, check that the DDR plugin file (DDR.dll) is stored in the following folder: ...\Agilent Technologies\VWorks\Plugins folder.

If you added the Direct Drive Robot plugin file in the Plugins folder and you have already started the VWorks software, be sure to reload the plugin. To do this, close any open device files and protocol files, and then select **Tools > Reload Plugins.**

2 In the device properties area, type a **Name** for the device.

In the following example, the name for the Direct Drive Robot is BioCel DD Robot.



3 Select the **Profile**.

If the profile you want does not appear in the list, or if no profile appears in the list, you need to:

- **a** Create the profile. See "Creating Direct Drive Robot profiles" on page 56.
- **b** Set up robot communication. See "Setting up robot communication" on page 58.
- **c** Set miscellaneous parameters. See "Setting miscellaneous parameters in the profile" on page 60.
- **d** Select a teachpoint file. See "Selecting a teachpoint file" on page 62.
- **e** Save the profile. See "Saving the profile" on page 64.
- **f** Initialize the profile. See "Initializing the profile" on page 65.
- **g** Return to this step to select the profile.

Without the profile, you will not be able to establish communication with the device.

4 If you have multiple Direct Drive Robots in the system, repeat steps 1 through 3 to add another Direct Drive Robot.

5 Select **File > Save** to save the device file.

6 In the **Device File** area, select the Direct Drive Robot, and then click **Initialize selected devices** to establish communication with the robot.

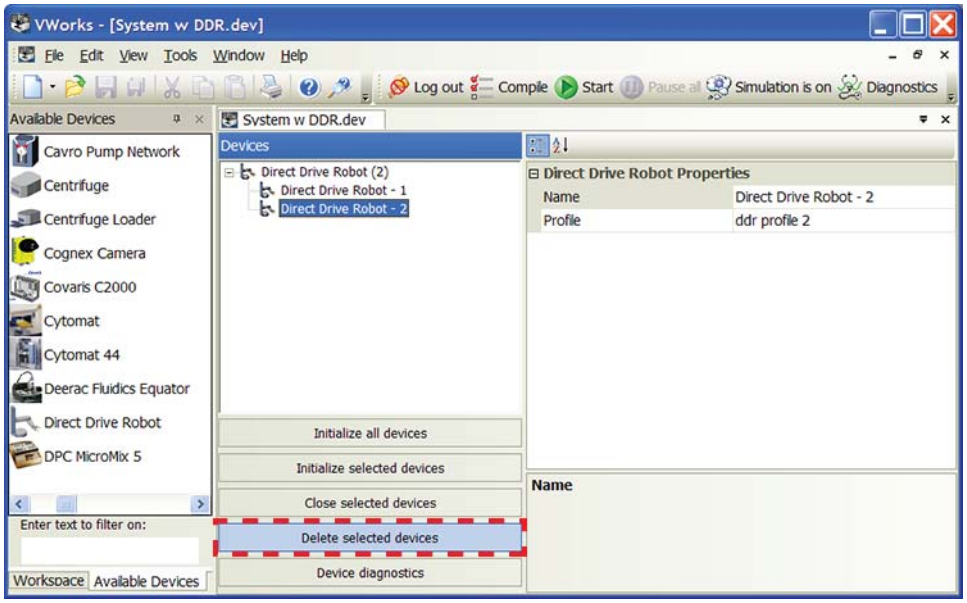
If an initialization error message appears, see "Resolving robot initialization errors" on page 200 for instructions.

Deleting a Direct Drive Robot from the device file

To delete a Direct Drive Robot from the device file:

1 In the **VWorks** window, select the Direct Drive Robot you want to delete in the **Devices** area.

2 Click **Delete selected devices.**



Related information

For information about...	See...
VWorks software	• *VWorks Automation Control Setup Guide* • *VWorks Automation Control User Guide*
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting robot communication	"Setting up robot communication" on page 58
Setting miscellaneous parameters in the profile	"Setting miscellaneous parameters in the profile" on page 60
Selecting a teachpoint file	"Selecting a teachpoint file" on page 62
Setting teachpoints	"Setting teachpoints" on page 77
Saving the profile	"Saving the profile" on page 64
Initializing the profile	"Initializing the profile" on page 65
Editing profiles	"Editing and managing profiles" on page 67
Managing existing profiles	"Managing profiles" on page 67

Creating Direct Drive Robot profiles

About this topic

This topic explains how to create a new profile for the Direct Drive Robot and how to manage existing profiles. For instructions on how to create the profiles for other Agilent Technologies devices, see the corresponding device user documentation. For instructions on how to create profiles for third-party devices, see the third-party device driver user guide.

About profiles

IMPORTANT Each device in the device file requires a unique profile.

A profile is a collection of settings, stored in the Windows registry, that manages how you connect to a device. A profile:

- Specifies the port or IP address used to establish communication between the device and the controlling computer.
- References a teachpoint file. For a description of teachpoint files, see "Setting teachpoints" on page 77.

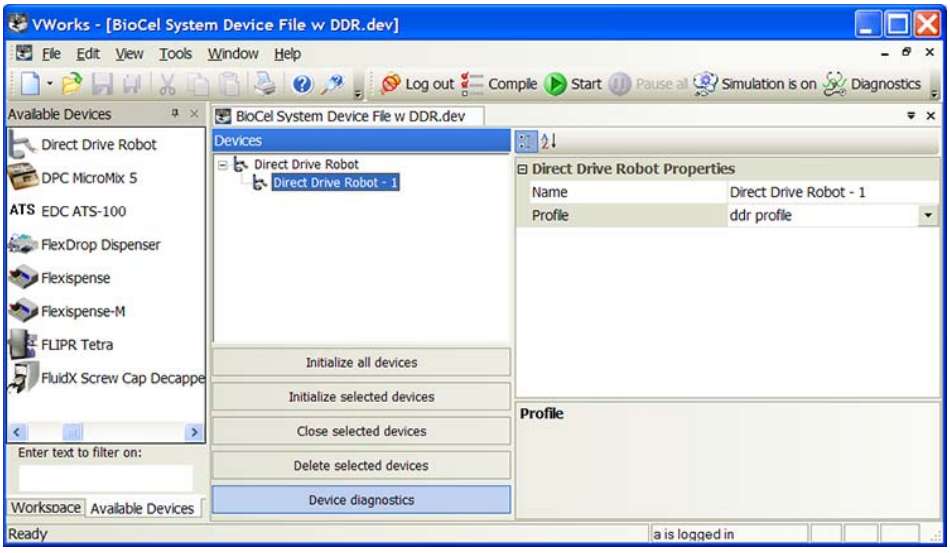
You use the DDR Diagnostics software to create and manage Direct Drive Robot profiles.

Note: The profile is referenced by a device file. For information about device files, see "What is a device file?" on page 51. For a detailed description of the relationships between the device file, profile, and teachpoint file, see the *VWorks Automation Control User Guide*.

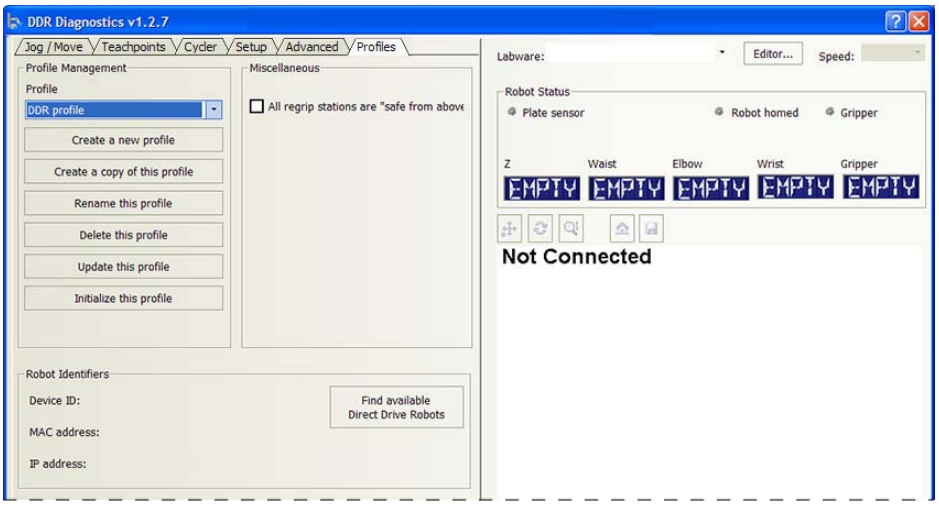
Creating a Direct Drive Robot profile

To create a Direct Drive Robot profile:

1 In the **Devices** area, select the Direct Drive Robot name, and then click **Device diagnostics.**



The DDR Diagnostics dialog box opens.



2 If it is not already displayed, click the **Profiles** tab.

3 In the **Profile Management** area, click **Create a new profile**. The Create Profile dialog box opens.

4 Type a name, and click **OK**. The name appears in the Profile Management area.

Related information

For information about...	See...
Setting robot communication	“Setting up robot communication” on page 58
Setting miscellaneous parameters in the profile	“Setting miscellaneous parameters in the profile” on page 60
Selecting a teachpoint file	“Selecting a teachpoint file” on page 62
Setting teachpoints	“Setting teachpoints” on page 77
Saving the profile	“Saving the profile” on page 64
Initializing the profile	“Initializing the profile” on page 65
Editing profiles	“Editing and managing profiles” on page 67
Managing existing profiles	“Managing profiles” on page 67

Setting up robot communication

About this topic

When you create a profile, you must also select the robot with which to establish communication. This topic explains how to locate the robot in the system network.

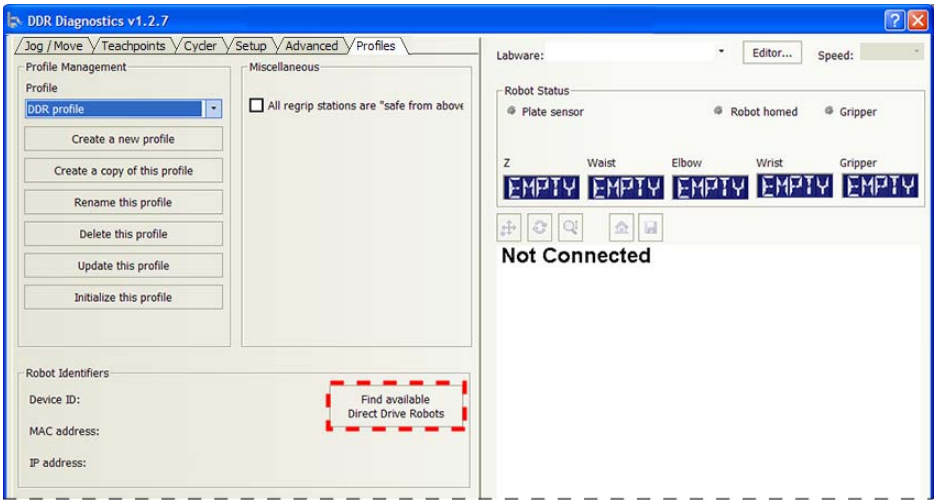
If you have more than one Direct Drive Robot in the system

Every device in the system must have a unique IP address for proper operation. All Direct Drive Robots are assigned the same IP address at the factory. Therefore, if you have more than one Direct Drive Robot installed in the system, you must make sure each is assigned a unique IP address. You can do this when creating a profile for the robot.

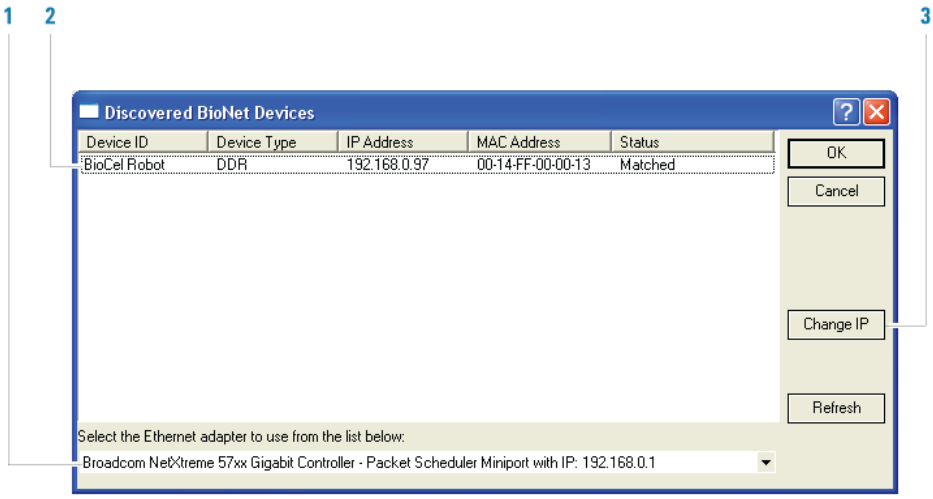
Procedure

To set up robot communication:

1 In the **Robot Identifiers** area, click **Find Available Direct Drive Robots.**



2 In the Discovered BioNet Devices dialog box that opens, locate the Direct Drive Robot to which you want to connect:



Step	Instruction
1	Select the correct Ethernet card for the device connection. A list of devices appear in the dialog box.
2	Select the Direct Drive Robot. You can use the MAC Address to identify the robot in the list. To successfully communicate with the robot, the device must show New or Matched in the Status column. To correctly identify a robot by its MAC address, you might need to turn off all devices and all but one robot in the system. After you have correctly identified the robot in the list, double-click the **Device ID** box and type a name for the robot.
3	If you have more than one Direct Drive Robot in the system, make sure each robot has a unique IP address. To do this, turn off all but one robot in the system, select the robot in this dialog box, click **Change IP**, and then assign a new IP address. The IP address should have the same network and subnet address as the controlling computer, and have a unique host address. Repeat for each robot in the system.

4 When you are finished, click **OK** to return to the DDR Diagnostics dialog box. Notice that the Device ID, MAC address, and IP address of the robot appear in the Robot Identifiers area.

Related information

For information about...	See...
Setting miscellaneous parameters in the profile	"Setting miscellaneous parameters in the profile" on page 60
Selecting a teachpoint file	"Selecting a teachpoint file" on page 62
Setting teachpoints	"Setting teachpoints" on page 77
Saving the profile	"Saving the profile" on page 64
Initializing the profile	"Initializing the profile" on page 65
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Editing profiles	"Editing and managing profiles" on page 67
Managing existing profiles	"Managing profiles" on page 67

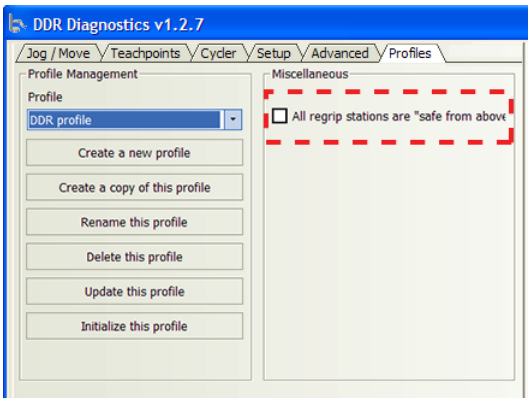
Setting miscellaneous parameters in the profile

Procedure

CAUTION Select this option only if all regrip stations in the system are clear of obstacles, such as shelves or other devices, above them.

To set miscellaneous parameters in the profile:

In the **Miscellaneous** area, make sure the **All regrip stations are safe from above** check box is not selected. You can return to the profile to select this option after you have set all teachpoints.



For a description of this option, see "Selecting the All regrip stations are safe from above option" on page 106.

Related information

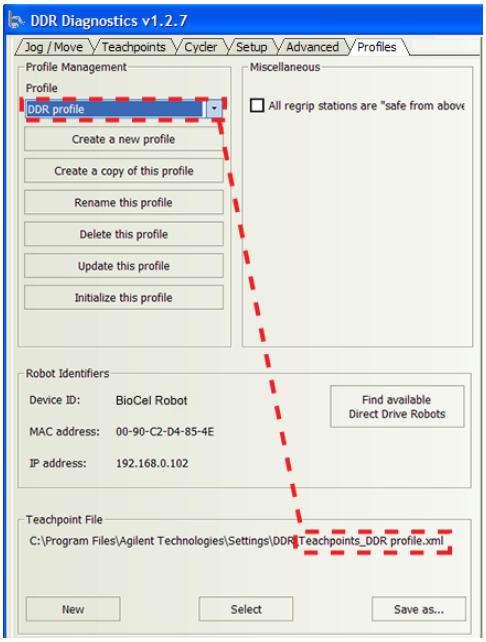
For information about...	See...
Selecting a teachpoint file	“Selecting a teachpoint file” on page 62
Setting teachpoints	“Setting teachpoints” on page 77
Saving the profile	“Saving the profile” on page 64
Initializing the profile	“Initializing the profile” on page 65
Creating profiles for the robot	“Creating Direct Drive Robot profiles” on page 56
Setting up robot communication	“Setting up robot communication” on page 58
Editing profiles	“Editing and managing profiles” on page 67
Managing existing profiles	“Managing profiles” on page 67

Selecting a teachpoint file

Direct Drive Robot profiles and teachpoint files

A teachpoint file contains the list of locations at which the robot will pick or place labware. For a detailed description of teachpoints and teachpoint files, see “Direct Drive Robot teachpoints” on page 79 and “Teachpoint files” on page 88.

Every Direct Drive Robot profile must be associated with a teachpoint file. When you create a profile, the software automatically creates a new default teachpoint file. Its location is shown in the Teachpoint File area. The file name is teachpoint_<profilename>, and the file remains empty until you set teachpoints.



Selecting the default teachpoint file

To use the default teachpoint file as is:

Proceed to “Saving the profile” on page 64. Later you will add teachpoints to this teachpoint file.

If you want to change the teachpoint file name or storage location, in the Teachpoint File area, click **Save as.** In the Save As dialog box, type a name for the teachpoint file, select the storage location, and then click **Save.** The file path appears in the Teachpoint File area. Later you will add teachpoints to this file.

Selecting an existing teachpoint file

If you want to use an existing teachpoint file:

In the **Teachpoint File** area, click **Select.** In the Select a Teachpoint File dialog box, locate and select the teachpoint file that you want to use, and then click **Open.** The file path appears in the Teachpoint File area.

CAUTION If the teachpoint file was copied from another computer, you must verify the teachpoints for the new profile before using it.

If you want to use an existing teachpoint file and rename it, you must select the existing teachpoint file, initialize the profile to load information in the existing teachpoint file ("Initializing the profile" on page 65), and then click **Save As** in the Teachpoint File area to rename it.

Related information

For information about...	See...
Setting teachpoints	"Setting teachpoints" on page 77
Saving the profile	"Saving the profile" on page 64
Initializing the profile	"Initializing the profile" on page 65
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting up robot communication	"Setting up robot communication" on page 58
Setting miscellaneous parameters in the profile	• "Setting miscellaneous parameters in the profile" on page 60 • "Selecting the All regrip stations are safe from above option" on page 106
Editing profiles	"Editing and managing profiles" on page 67
Managing existing profiles	"Managing profiles" on page 67

Saving the profile

Procedure

After you have finished setting up robot communication and profile parameters, you can save the profile.

To save the profile:

Click **Update this profile** to save the changes.

Related information

For information about...	See...
Initializing a profile	"Initializing the profile" on page 65
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting up robot communication	"Setting up robot communication" on page 58
Setting miscellaneous parameters in the profile	• "Setting miscellaneous parameters in the profile" on page 60 • "Selecting the All regrip stations are safe from above option" on page 106
Selecting a teachpoint file	"Selecting a teachpoint file" on page 62
Setting teachpoints	"Setting teachpoints" on page 77
Editing profiles	"Editing and managing profiles" on page 67
Managing profiles	"Managing profiles" on page 67

Initializing the profile

About the initialization process

You initialize the profile to:

- Establish communication with the robot.
- Load the information in the selected teachpoint file.
- Synchronize the teachpoints information in the firmware with that in the teachpoints file.

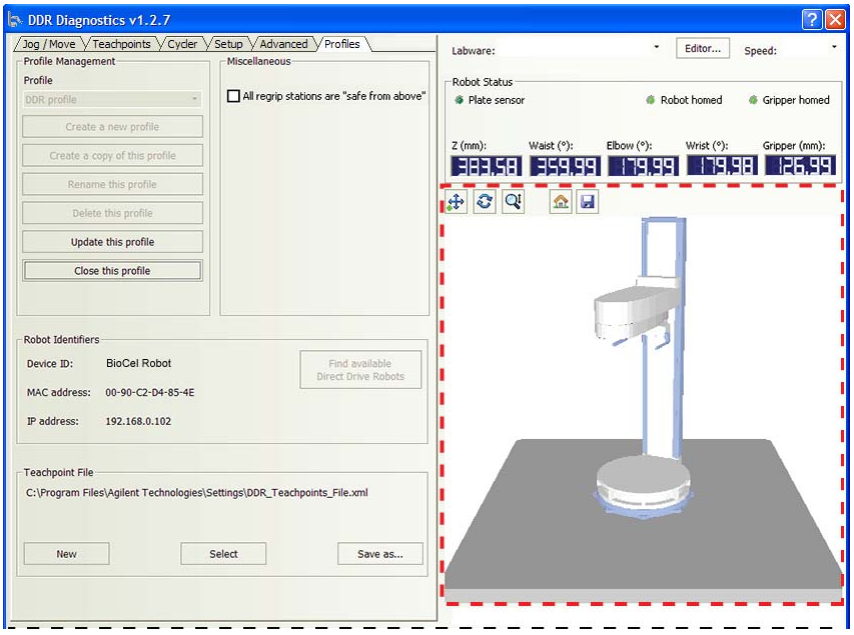
Procedure

WARNING **The robot might move its arm during the initialization process. Keep out of the system during the initialization process.**

To initialize the profile:

Click **Initialize this profile.** In the Robot Status area, a graphical representation of the robot and teachpoints (if any) appear. In addition, the robot coordinates are updated.

IMPORTANT The system table displayed in the Robot Status area should be representative of the actual system table. If no image appears, or if the dimensions in the image appears to be incorrect (for example, a rectangular table appears in the software but the actual system table is square), see "Specifying the table dimensions and robot position" on page 69.



If you are setting up the Direct Drive Robot for the first time or if you are creating a new device file, return to "Adding and deleting Direct Drive Robots in the device file" on page 53 and continue from step 3. Otherwise, you can proceed to set teachpoints. See "Planning Direct Drive Robot teachpoints" on page 79.

Related information

For information about...	See...
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting up robot communication	"Setting up robot communication" on page 58
Setting miscellaneous parameters in the profile	• "Setting miscellaneous parameters in the profile" on page 60 • "Selecting the All regrip stations are safe from above option" on page 106
Selecting a teachpoint file	"Selecting a teachpoint file" on page 62
Saving the profile	"Saving the profile" on page 64
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Editing profiles	"Editing and managing profiles" on page 67
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Editing and managing profiles

Editing profiles

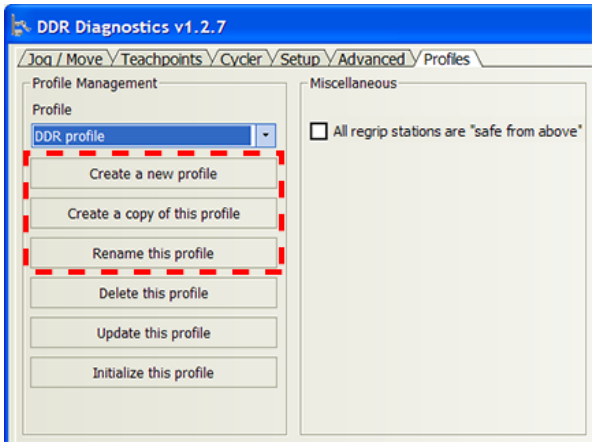
To edit a profile:

1. In the Direct Drive Robot Diagnostics **Profiles** tab, select the profile you want to edit in the **Profile Management** area.
2. Modify the profile information.
3. When you are finished, click **Update this profile** to save the changes.

Managing profiles

In the DDR Diagnostics **Profiles** tab, you can select an existing profile, and then rename, copy, or delete the profile.

CAUTION A copy of an existing profile references the same teachpoint file.



Related information

For information about...	See...
Creating profiles for the robot	"Creating Direct Drive Robot profiles" on page 56
Setting up robot communication	"Setting up robot communication" on page 58
Setting miscellaneous parameters in the profile	• "Setting miscellaneous parameters in the profile" on page 60 • "Selecting the All regrip stations are safe from above option" on page 106
Selecting a teachpoint file	"Selecting a teachpoint file" on page 62

For information about...	See...
Saving the profile	“Saving the profile” on page 64
Initializing the profile	“Initializing the profile” on page 65
Setting teachpoints	“Setting teachpoints” on page 77
Editing profiles	“Editing and managing profiles” on page 67
Managing profiles	“Managing profiles” on page 67

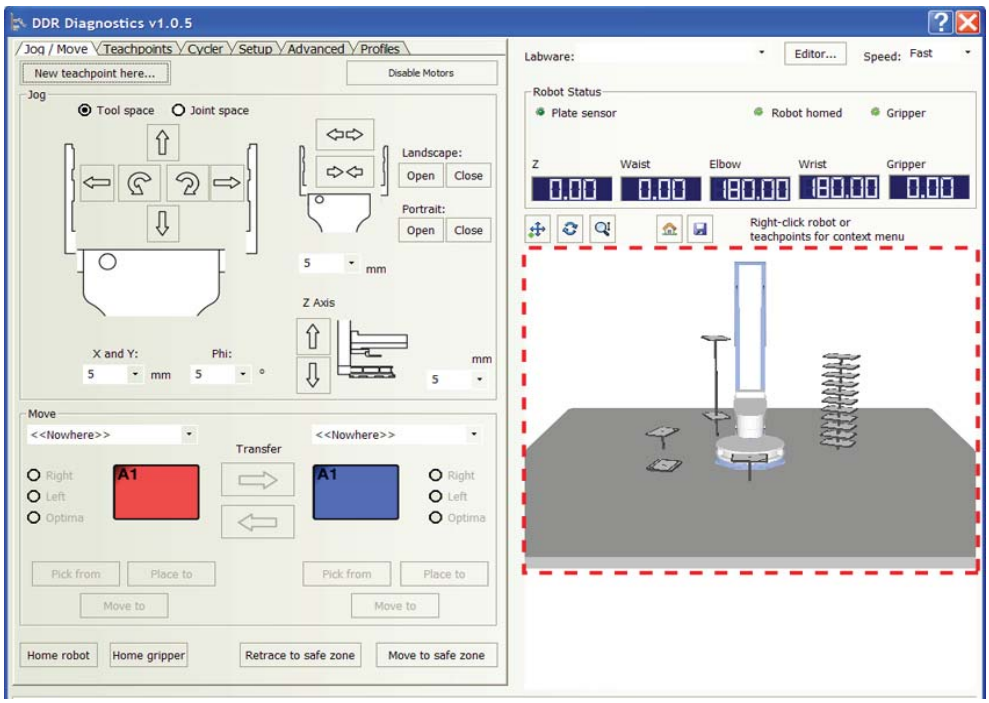
Specifying the table dimensions and robot position

About the table dimensions and robot position

When you set up the robot, you must let the software know the following:

- Dimensions of the attachment surface (or table)
- Position of the robot on the table
- Orientation of the robot on the table

This information helps the software to draw an accurate representation of the table and display the relative positions of the robot and teachpoints in the Robot Status area.



To specify the table dimensions and robot position, you will be:

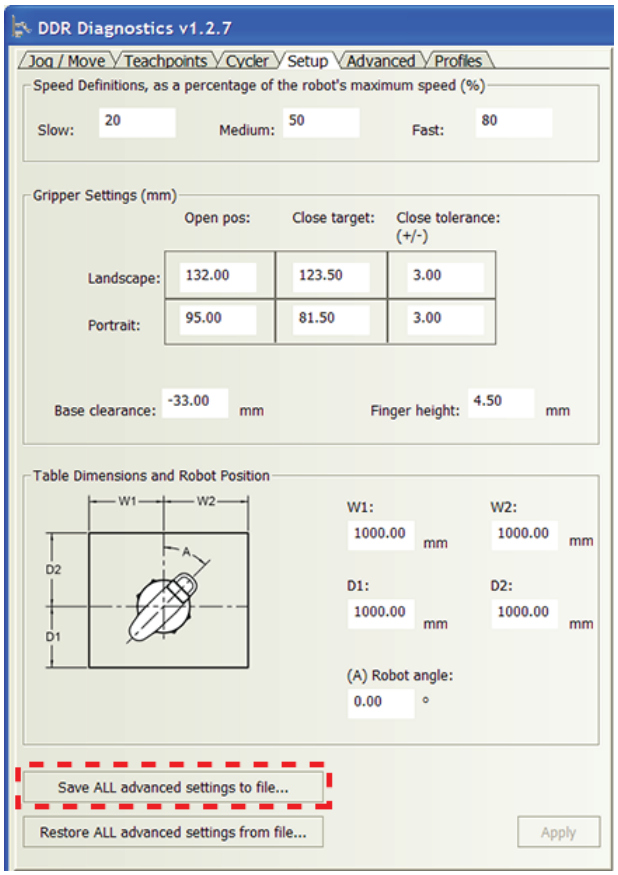
- "Backing up existing settings" on page 69
- "Measuring the table dimensions" on page 70
- "Determining the angle of the robot" on page 71
- "Entering the information in DDR Diagnostics" on page 73

Backing up existing settings

Agilent Technologies recommends that you back up existing table dimensions and robot position settings before changing them.

To back up existing settings:

1 In the **DDR Diagnostics Setup** tab, click **Save ALL advanced settings to file.**

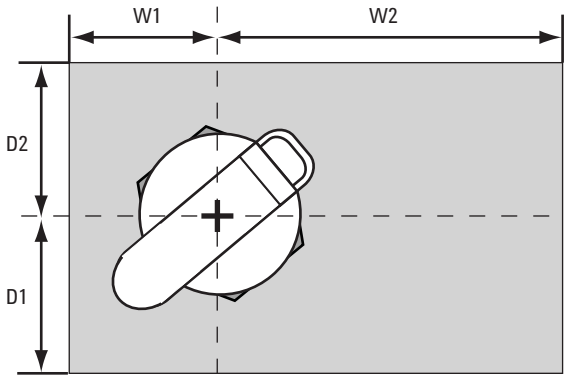


2 In the Save As dialog box that opens, type a name for the backup file. You can use the default backup file location, or select a different location. The default location is C:\Program Files\Agilent Technologies\Settings\DDR\FirmwareBackup.

3 Click **Save.** The robot settings are saved in an XML file.

Measuring the table dimensions

Take the measurements that are shown in the following diagram. The crosshair symbol in the diagram marks the center of the robot. The *W*-axis is width of the robot-attachment surface. W1 and W2 specify the lengths of the two segments of the width. The line that intercepts the end of W1 and the beginning of W2 runs through the center of the robot base. The *D*-axis is the depth of the robot-attachment surface. D1 and D2 specify the lengths of the two segments of the depth. The line that intercepts the end of D1 and the beginning of D2 runs through the center of the robot base.

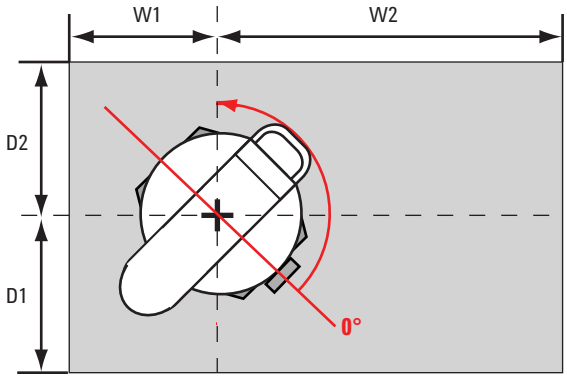


Note: The measurements can be approximate and the axis assignment is arbitrary. The information is used to draw the graphic in DDR Diagnostics and is not used for robot operation.

Determining the angle of the robot

During this procedure, you will determine the angle between the robot 0° position relative to the *D*-axis. The robot is at its 0° position when the mast sits directly above the robot cable connection.

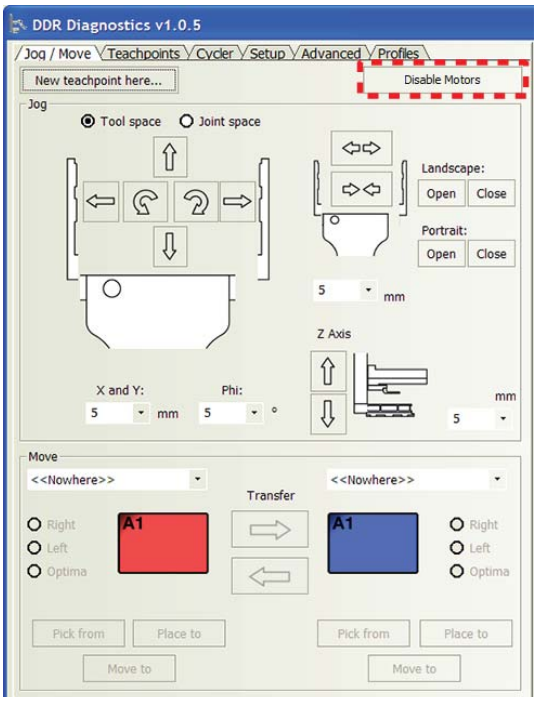
The following diagram shows the robot rotated halfway between the 0° position and the *D*-axis. Notice the location of the robot cable connection (the gray rectangular block).



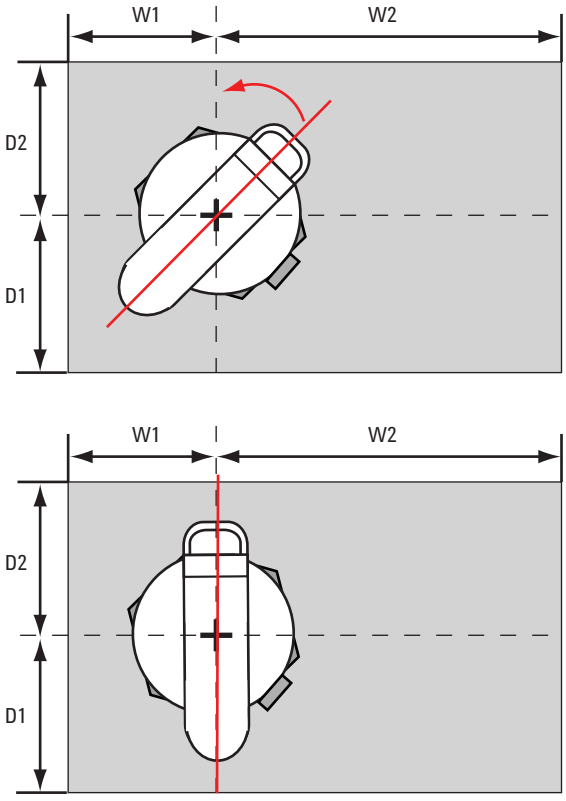
WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

To determine the angle of the robot:

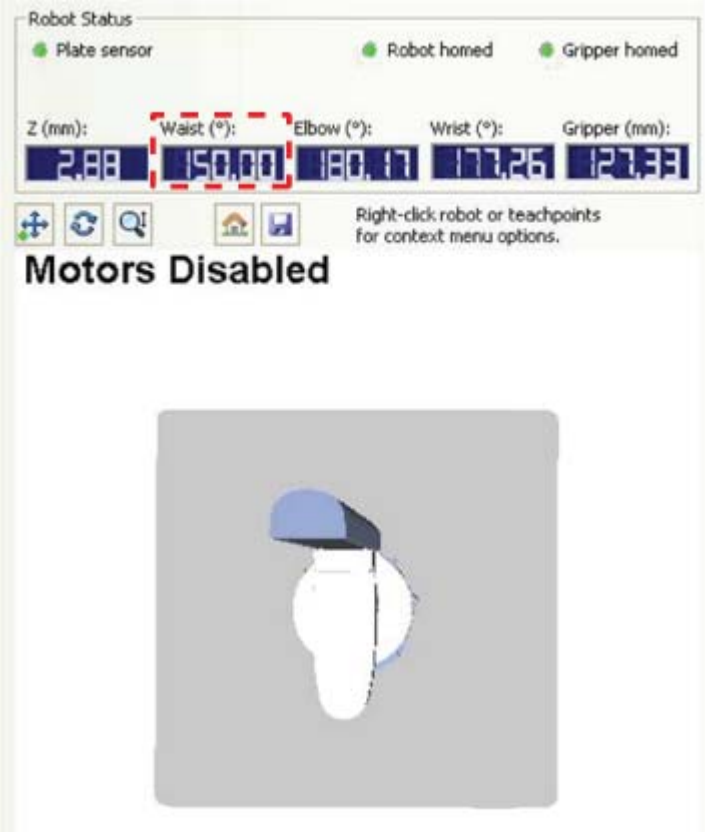
1 In Direct Drive Robot Diagnostics, click the **Jog/Move** tab, and then click **Disable Motors.** You should be able to rotate the robot waist and arm manually without resistance.



2 Turn the robot waist such that the bicep is parallel to the *D*-axis and the mast is in the D2 half of the plane.



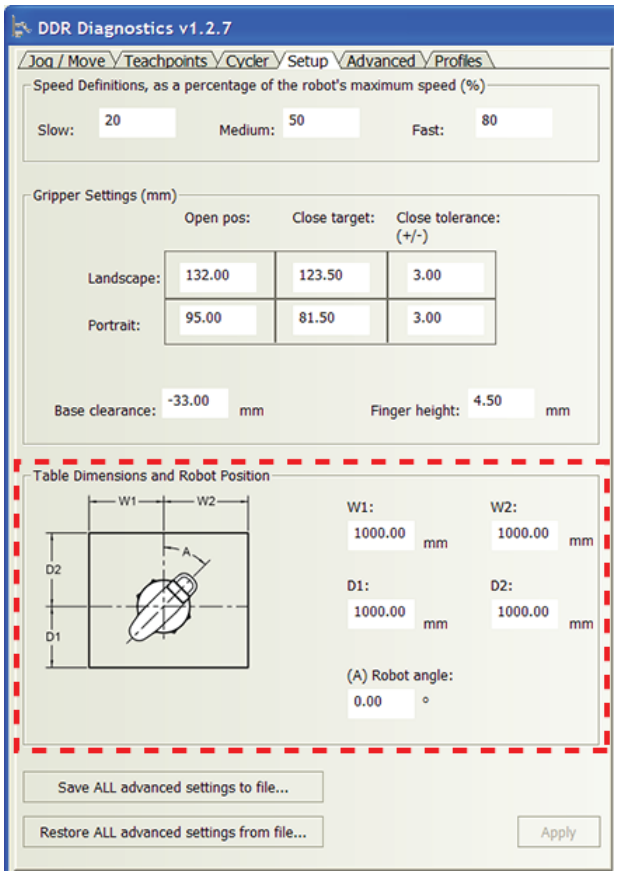
3 In Direct Drive Robot Diagnostics, note the **Waist** angle in the **Robot Status** area. This is the robot angle value you will use.



Entering the information in DDR Diagnostics

To set or update the table dimensions and robot position

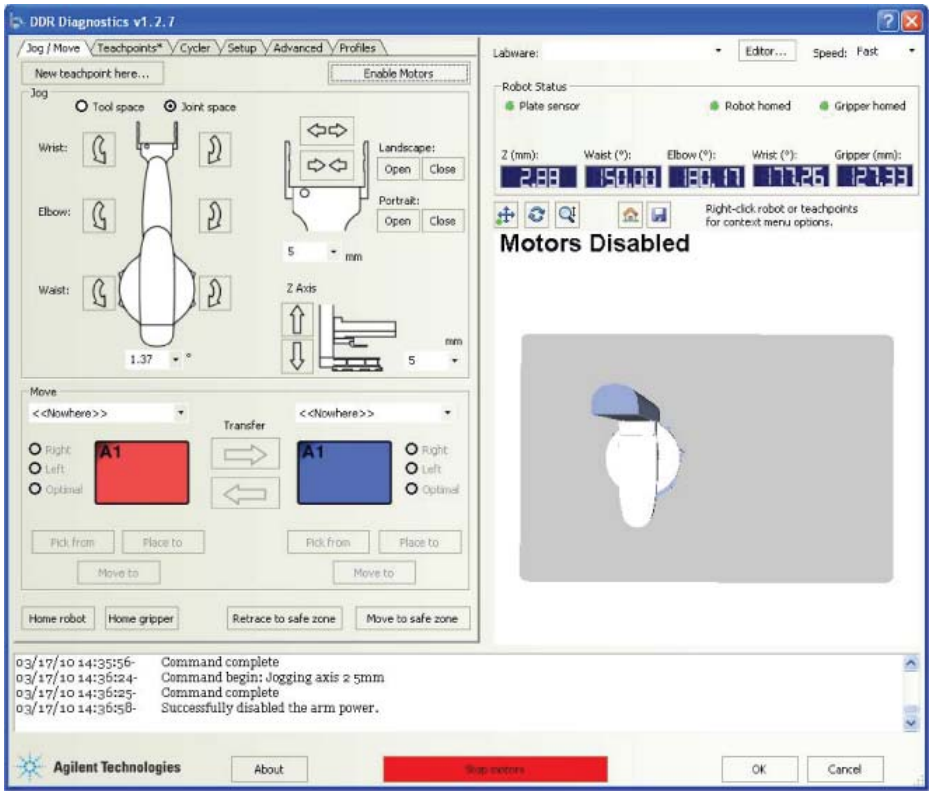
1 In DDR Diagnostics, click the **Setup** tab.



2 In the **Table Dimensions and Robot Position** area, type the desired values that define the table: **W1**, **W2**, **D1**, and **D2.**

3 Type the **Robot angle** value. This is the Waist angle value displayed in the Robot Status area.

4 When you are finished, click **Apply.** The changes are saved to the firmware. In addition, the graphic in the Robot Status area updates.



5 Check the graphic and make sure it is correct. If necessary, repeat the procedures in this topic to make any necessary adjustments. For example, if the robot appears backwards in the software, you can rotate the D- and W-axes in the Setup tab.

6 After you have verified that the table settings are correct, click **Save ALL advanced settings to file.** The values in the Setup tab are saved to an XML file. You can use the XML file to recover the settings if they are lost.

Related information

For information about...	See...
Homing the robot	“Homing the robot and grippers” on page 140
Planning teachpoints	“Planning Direct Drive Robot teachpoints” on page 79
Setting teachpoints	“Setting teachpoints” on page 77

5 Setting teachpoints

This chapter explains how to set up the Direct Drive Robot for operation. This chapter contains the following topics:

- "Teachpoint setting workflow" on page 78
- "Planning Direct Drive Robot teachpoints" on page 79
- "Setting teachpoints" on page 88
- "Setting teachpoints using a labware" on page 107
- "Verifying teachpoints" on page 109
- "Editing existing teachpoints" on page 121
- "Managing teachpoints" on page 125
- "Cycling teachpoints" on page 126

Teachpoint setting workflow

About this topic

This topic presents the workflow for setting Direct Drive Robot teachpoints.

WARNING **Only administrators and experienced personnel should perform the procedures in this chapter.**

Workflow

The following table presents the steps for setting Direct Drive Robot teachpoints. After setting the teachpoints, you will not likely change them unless you add, replace, move, or remove a device in the system.

IMPORTANT Before proceeding to step 3 (verify the teachpoints), or if you use a labware to set teachpoints, you should already have definitions for the labware you want to use. Although you can define labware at any time, Agilent Technologies recommends that you define labware before setting the teachpoints. For instructions on how to define labware, see the *VWorks Automation Control Setup Guide*.

Step	For this task...	See...
1	Plan the teachpoints.	"Planning Direct Drive Robot teachpoints" on page 79
2	Set teachpoints at device locations.	• "Setting teachpoints" on page 88 • "Setting teachpoints using a labware" on page 107
3	Verify the teachpoints.	"Verifying teachpoints" on page 109
4	Edit the teachpoints.	• "Editing existing teachpoints" on page 121 • "Managing teachpoints" on page 125
5	Cycle the teachpoints.	"Cycling teachpoints" on page 126

Planning Direct Drive Robot teachpoints

About this topic

The Direct Drive Robot is able to hold labware in both the landscape and portrait orientations. In addition, the A1 well can be away or toward the robot grippers in either labware orientation.

The orientation flexibility permits multiple options at each teachpoint. Carefully planned teachpoints can optimize results and throughput. This topic presents the following:

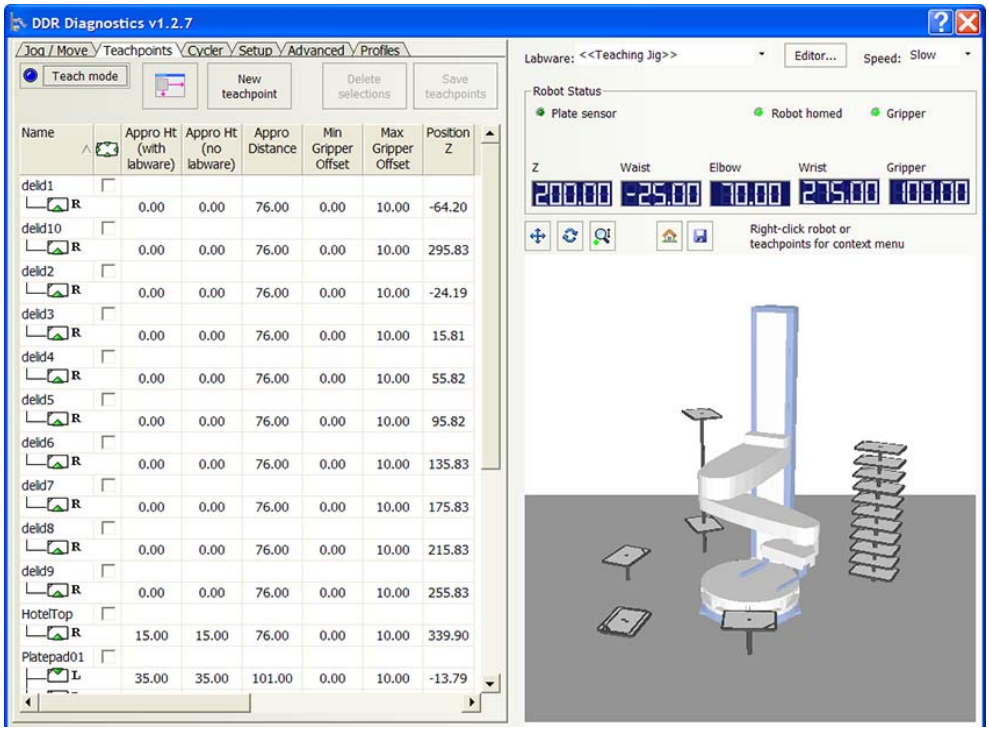
- "Direct Drive Robot teachpoints" on page 79
- "Guidelines for setting teachpoints" on page 82
- "Examples" on page 83

Direct Drive Robot teachpoints

A Direct Drive Robot teachpoint consists of the following:

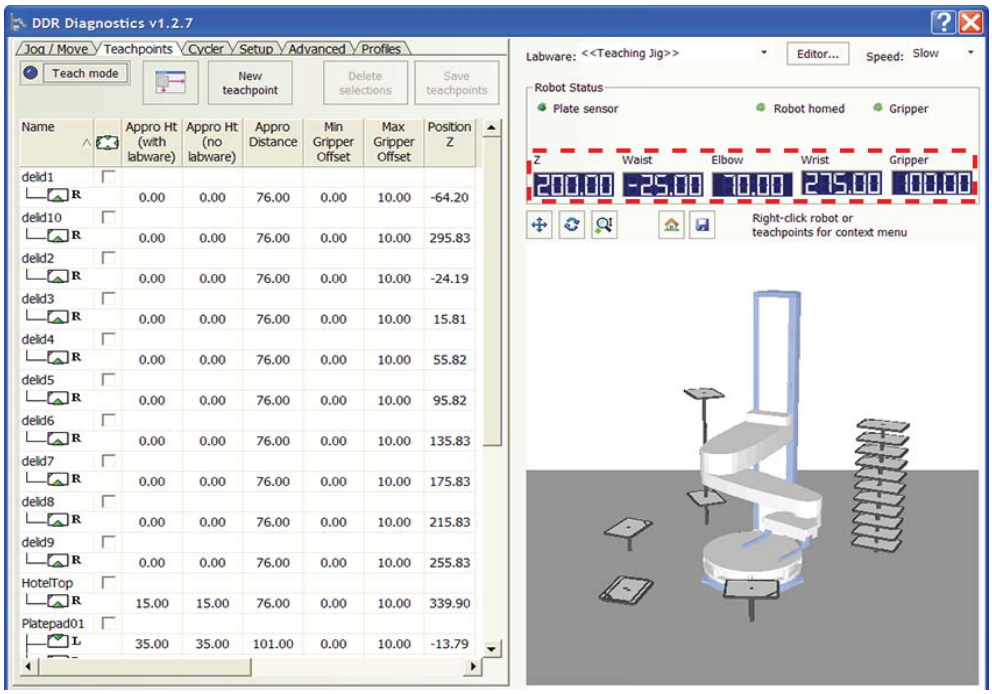
- Orientation coordinates
- Orientation information
- Parameters that define robot movements near and at the teachpoint

You set and edit teachpoints in the DDR Diagnostics Teachpoints tab.



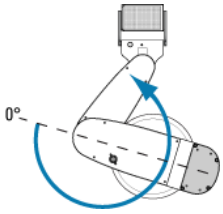
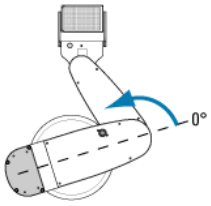
Orientation coordinates

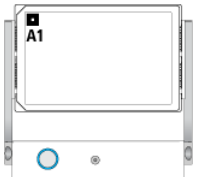
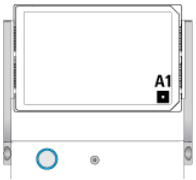
A teachpoint is defined by a set of coordinates that define where the robot picks up or places labware. The teachpoint can be on an integrated device or a platepad. Teachpoints are relative to the robot home position. You can view the teachpoint or robot coordinates in the Teachpoints tab in DDR Diagnostics.



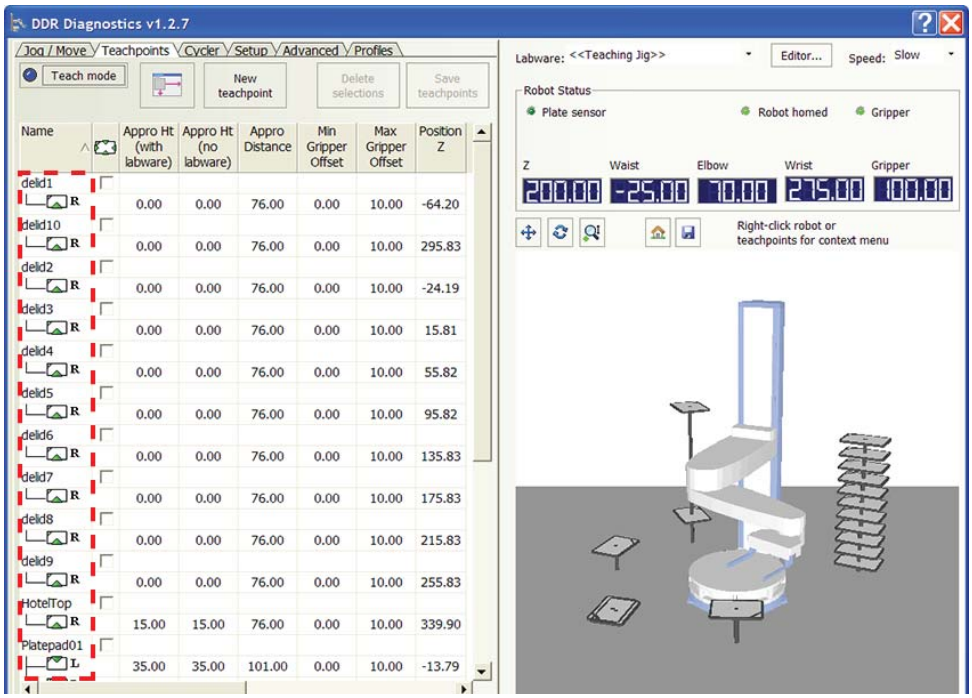
Orientation information

Each teachpoint contains the following orientation information:

Orientation	Description	
Robot arm	Left (L), elbow joint angle of >= 180°	Right (R), elbow joint angle < 180°
		
Labware	Landscape	Portrait

Orientation	Description	
A1 well	Away from the robot grippers in either labware orientation	Toward the robot grippers in either labware orientation
		

The orientation information is displayed in the Teachpoints tab in DDR Diagnostics.



Parameters that define robot movements

A number of parameters define the robot movements near or at a teachpoint:

- Approach height
- Approach distance
- Gripper offset at the location
- Custom actions (delidding, lidding, stirring, or push-down action)

For more information, see “Creating a new teachpoint” on page 93.

Guidelines for setting teachpoints

Before setting teachpoints, determine the best orientations for each location. In addition, be aware of how varying robot and labware orientations between teachpoints can affect robot speed and efficiency.

Orientations to consider

Before you set a teachpoint, take into consideration all of the following:

- *Robot-arm orientation*. Determine the best robot-arm orientation (left or right) for the location. The accessibility of a location can determine the robot-arm orientation. See "Examples" on page 83.
- *Labware orientation*. Determine the best labware orientation (landscape or portrait) for the location. The orientation might be determined by device requirements. For example, the Labware Stacker requires labware to be in the landscape orientation, but the portrait Plate Hub Carousel requires labware to be in the portrait orientation.
- *A1-well orientation*. Determine the A1-well orientation of the labware. In general, for devices that require the landscape orientation, such as the Labware Stacker and the landscape Plate Hub Carousel, the optimal A1-well orientation is typically away from the grippers. For storage devices that require the portrait orientation, the optimal A1-well orientation depends on the requirements at other teachpoints in the system. See "Examples" on page 83.

For a description of the orientations, see "Orientation information" on page 80.

Factors that affect robot speed and efficiency

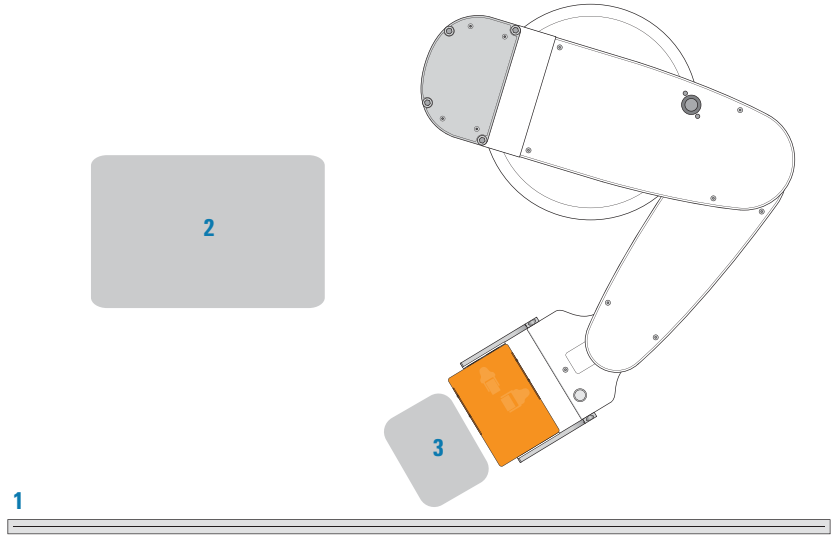
To increase robot speed and efficiency, you should:

- *Maximize the robot's ability to plan optimal paths*. Wherever possible, set a teachpoint with as many orientations as possible so that the robot can determine the optimal path during the run. For example, set a teachpoint with both the right- and left-arm orientations.
- *Minimize the number of regrips between teachpoints*. A regrip is required if, for example, the robot is transferring a labware from one location that requires one labware orientation to another location that requires a different labware orientation. To minimize the time required for regripping, wherever possible, set a teachpoint with multiple orientations and allow the robot to determine the optimal path during the run. Alternatively, consistently set teachpoints using one orientation wherever possible. For more information about regrip stations, see "Designating a teachpoint as a regrip station" on page 97.
- *Maximize the gripper offset ranges*. A regrip station is also used if the robot needs to adjust gripping height as it transfers a labware from one location that requires a gripper height that is different from the next location. To provide the system with the greatest flexibility for identifying a grip position that works for all locations, you should set the widest possible range for each gripper offset parameter. For more information about gripper offset ranges, see "Setting the gripper offset parameters" on page 102.
- *Set Approach Distance at the smallest possible value*. In general, rotating robot movements are faster than straight movements. To ensure that the robot rotates from the safe zone directly to the teachpoint approach height, set the Approach Distance at 0. If obstacles near or at the teachpoint does not permit the rotating movement, set the Approach Distance at the smallest possible value for the location. For more information, see "Setting the approach distance" on page 100.

Examples

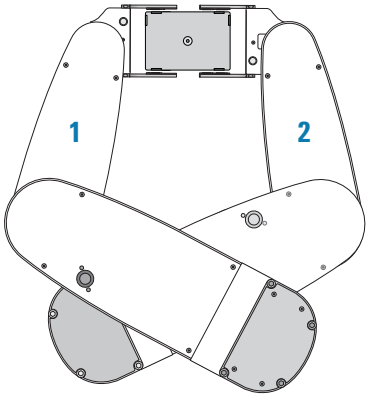
Example 1: Robot-arm orientation

In the following example, the system window (1) and an adjacent device (2) are two obstacles near the desired location (3). Therefore, the left-arm orientation should be used when setting the teachpoint.



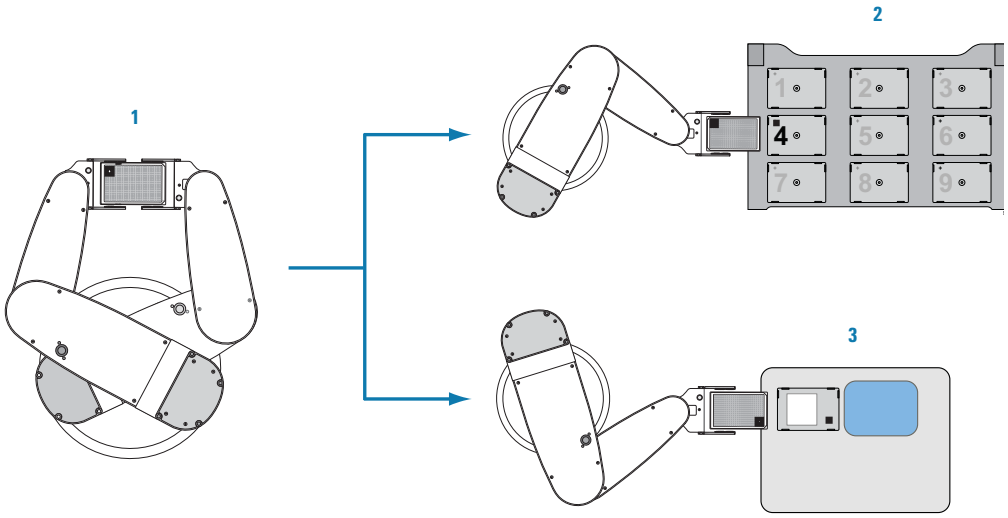
Example 2: Robot-arm and A1-well orientation

In the following example, there are no obstacles near the platepad in the portrait orientation. You can set the platepad teachpoint with the left- (1) and right-arm (2) orientations.



The position of the A1 well is device dependent. So the arm orientation the robot uses at this platepad is determined by the A1-well orientation at the next teachpoint.

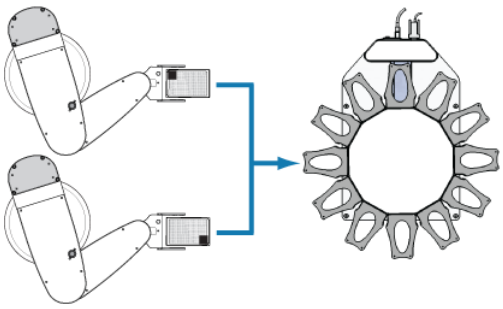
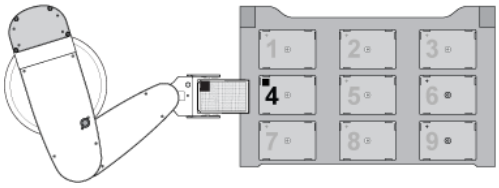
In the following example, the labware is placed at the platepad with the A1 well positioned as shown (1). If the next device requires the A1 well to be toward the grippers (2), the robot will use the left-arm orientation. However, if the next device requires the A1 well to be away from the grippers (3), the robot will use the right-arm orientation.



Example 3: Plate Hub Carousel - Bravo deck location 4 - Plate Hub Carousel

A protocol requires labware to be moved from a portrait Plate Hub Carousel slot to the Bravo Platform for liquid-handling tasks. After processing, the labware must be moved from the Bravo Platform and returned to the portrait Plate Hub Carousel slot.

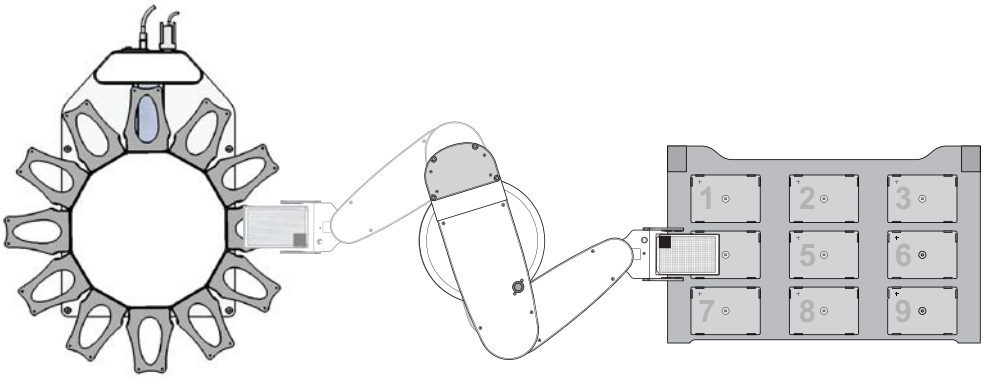
The labware orientation option or requirement at each device is as follows:

Device	Orientation option or requirement
Portrait Plate Hub Carousel (top view): • Portrait • A1 either away or toward the grippers	
Bravo Platform (top view): • Portrait • A1 toward the grippers	

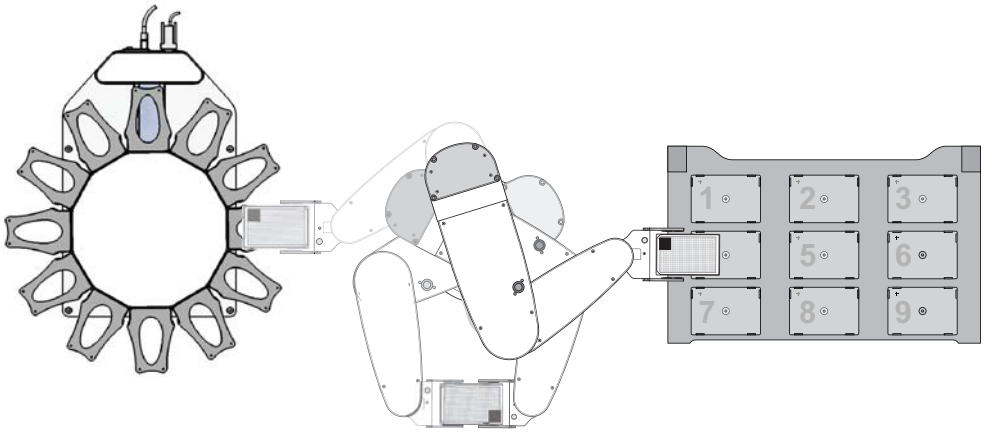
Note: In the example setup, the robot can only approach the Bravo deck as shown.

The optimal teachpoint setup at the Plate Hub Carousel would require the least number of regrips as the labware is transferred between the two devices.

If the Plate Hub Carousel teachpoint is set with the A1-toward orientation, the robot can transfer the labware from the Plate Hub Carousel to the Bravo Platform without regripping. Therefore, the A1-toward orientation at the Plate Hub Carousel is the optimal setup.



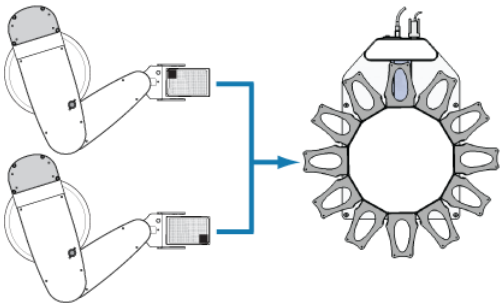
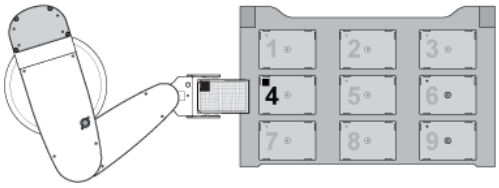
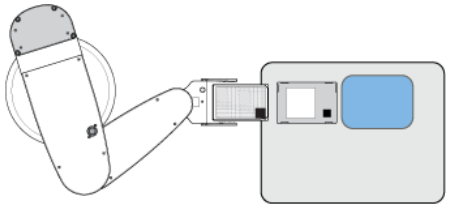
If the Plate Hub Carousel teachpoint is set with the A1-away orientation, the robot must regrip the labware during the transfer. Therefore, the A1-away orientation at the Plate Hub Carousel is not the optimal setup.



Example 4: Repeating tasks and regrip frequency

A protocol requires labware to be moved from a portrait Plate Hub Carousel slot to the Bravo Platform for liquid-handling tasks. After processing, the labware must be moved from the Bravo Platform to a dispenser. Subsequent protocol tasks move the labware multiple times between the dispenser and the Plate Hub Carousel for cycles of dispensing and incubation.

The labware orientation option or requirement at each device is as follows:

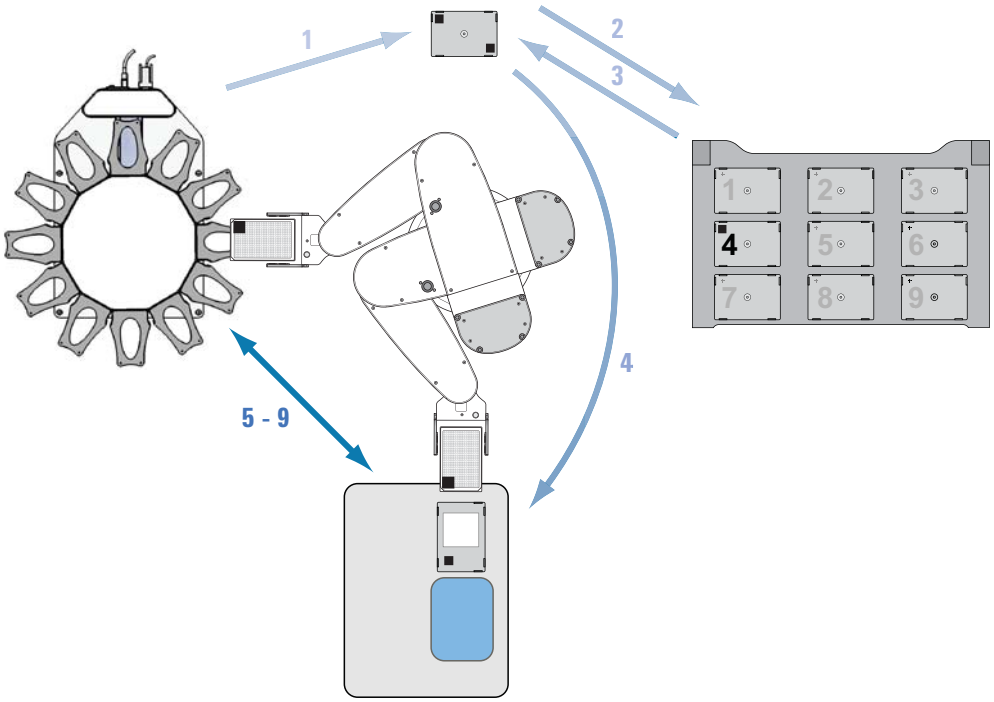
Device	Orientation option or requirement
Portrait Plate Hub Carousel (top view): • Portrait • A1 either away or toward the grippers	
Bravo Platform (top view): • Portrait • A1 toward the grippers	
Dispenser (top view): • Portrait • A1 away from the grippers	

Note: In the example setup, the robot can only approach the Bravo deck and the dispenser as shown.

The optimal teachpoint setup at the Plate Hub Carousel would require the least number of regrips as the labware is transferred between the three devices.

If the Plate Hub Carousel teachpoint is set with the A1-away orientation, the robot must regrip as it moves labware from the Plate Hub Carousel to the Bravo deck (**1**, **2**), and regrip again as it moves the labware from the Bravo deck to the dispenser (**3**, **4**). Thereafter, the robot can move the labware between the dispenser and Plate Hub Carousel without regripping (**5–9**). So the total number of regrips in this scenario is two.

Note: In general, to minimize the number of regrips, consider matching the orientations of consecutive teachpoints in repeating protocol tasks.



If the Plate Hub Carousel teachpoint is set with the A1-toward orientation, the robot can move labware from the Plate Hub Carousel to the Bravo deck without regripping. However, the robot must regrip as it moves labware from the Bravo deck to the dispenser, and then multiple times as it moves labware between the dispenser and Plate Hub Carousel in cycles of dispensing and incubation. The total number of regrips is greater than two. Therefore, the A1-toward orientation at the Plate Hub Carousel is not the optimal setup.

Related information

For information about...	See...
Teachpoint files	“Teachpoint files” on page 88
Setting teachpoints	“Setting teachpoints” on page 88

Setting teachpoints

About this topic

Depending on the type of device, the teachpoint setting procedure can vary. This topic provides basic teachpoint setting concepts: how to use the supplied teaching jig or the desired labware to set, verify, and edit Direct Drive Robot teachpoints.

Teachpoint files

The teachpoints you set are saved in the XML format in a teachpoint file. The default teachpoint file name is Teachpoints_<profilename>.xml, where <profilename> is the name of the profile. The software saves the file in the C:\Program Files\Agilent Technologies\Settings\DDR folder. However, you can select another file name and location when saving the file.

CAUTION Always edit and manage teachpoints in the Robot Diagnostics software. Do not edit the teachpoint file (XML file) directly. Editing the file directly can cause the robot to move to incorrect locations and bump into devices or other obstacles.

You can have multiple teachpoint files for each Direct Drive Robot if a device needs to serve multiple purposes. For example, a platepad can be taught as a platepad or as a regripping station. You can also have multiple teachpoint files for the system if a device is only used in some protocols but not others. For example, if a device is installed on a docking table and can be removed when it is not in use.

CAUTION Before you begin changing teachpoints, make a backup copy of the teachpoint file. If the original file becomes lost or damaged, you can use the backup copy instead of reteaching all the positions.

The teachpoint file is referenced by a profile. For information about profiles, see “Creating Direct Drive Robot profiles” on page 56.

Workflow

The workflow for setting a Direct Drive Robot teachpoint is as follows:

Step	For this task	See...
1	Install the teaching jig in the robot grippers. If size restrictions at teachpoints prevent the use of the teaching jig, use the labware intended for the location.	One of the following: • "Installing and removing the teaching jig in the robot grippers" on page 90 • "Setting teachpoints using a labware" on page 107
2	Create a new teachpoint.	"Creating a new teachpoint" on page 93
3	Name the teachpoint.	"Naming the teachpoint" on page 94
4	Specify the A1-well orientation.	"Specifying the A1-well orientation" on page 94
5	*Optional.* Designate a teachpoint as a regrip station.	"Designating a teachpoint as a regrip station" on page 97
6	Set teachpoint parameters: • Set the approach height. • Set the approach distance. • Set the gripper offset range. • Fine-tune the teachpoint coordinates. • Select custom actions.	• "Setting the approach height" on page 99 • "Setting the approach distance" on page 100 • "Setting the gripper offset parameters" on page 102 • "Setting the Position Z, Waist, Elbow, and Wrist parameters" on page 103 • "Selecting custom actions" on page 103
7	Save the teachpoints.	"Saving the teachpoints" on page 104
8	*Optional.* Selecting the All regrip stations are safe from above option.	"Selecting the All regrip stations are safe from above option" on page 106
9	Verify the teachpoints.	"Verifying teachpoints" on page 109
10	Edit the teachpoints.	"Editing existing teachpoints" on page 121
11	Cycle the teachpoints.	"Cycling teachpoints" on page 126

Before you start

Make sure:

- You review the guidelines for setting teachpoints ("Planning Direct Drive Robot teachpoints" on page 79).
- You have the provided Direct Drive Robot teaching jig. If size restrictions at teachpoints prevent the use of the teaching jig, use the labware intended for the location. See "Setting teachpoints using a labware" on page 107.
- You have a 2-mm hex wrench for installing and removing the teaching jig.
- The correct profile is initialized ("Creating Direct Drive Robot profiles" on page 56).
- The safety interlock is turned off (see the system user documentation).

Installing and removing the teaching jig in the robot grippers

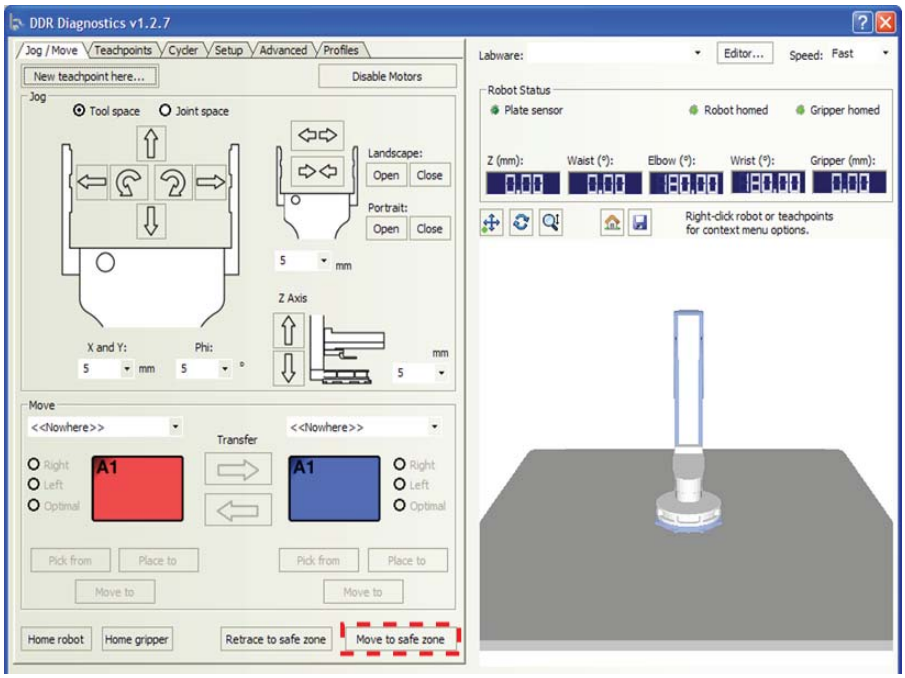
WARNING **Always wear protective eyewear when entering the system and working with the robot.**

WARNING **Stay out of the system when the robot is in motion.**

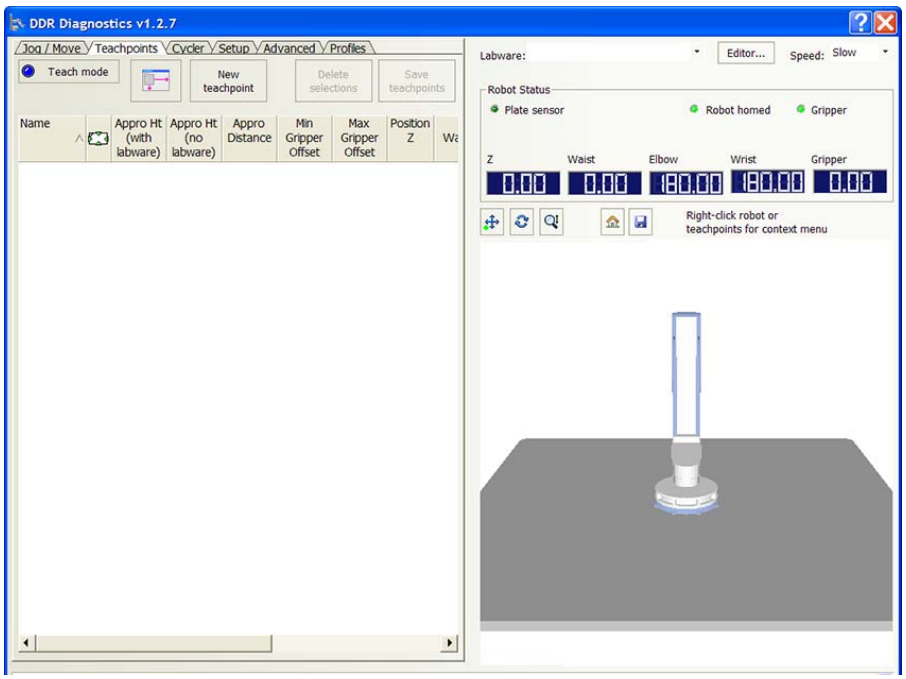
IMPORTANT If size restrictions at a teachpoint prevent the use of the teaching jig, use the labware intended for the location. For information, see "Setting teachpoints using a labware" on page 107.

To install the teaching jig:

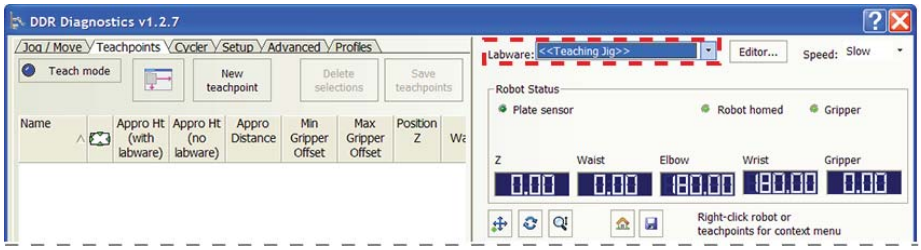
1 In **DDR Diagnostics,** click the **Jog/Move** tab, and then click **Move to safe zone.** The robot moves into its safe zone.



2 In **DDR Diagnostics,** click the **Teachpoints** tab.

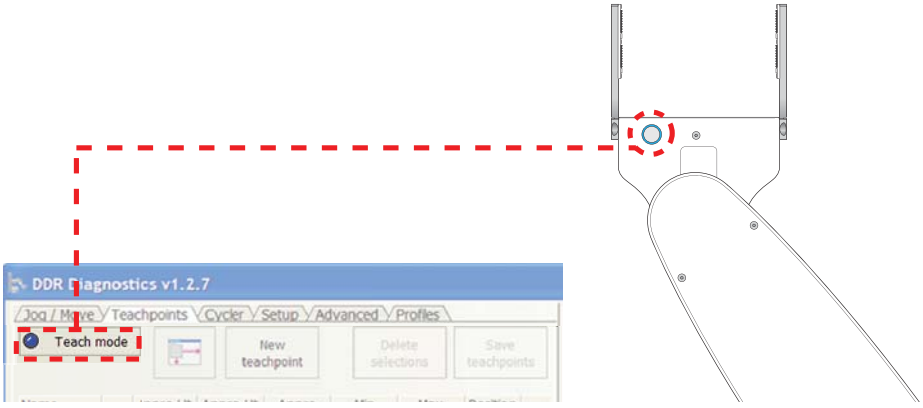


3 In the **Labware** list, select **Teaching jig.**



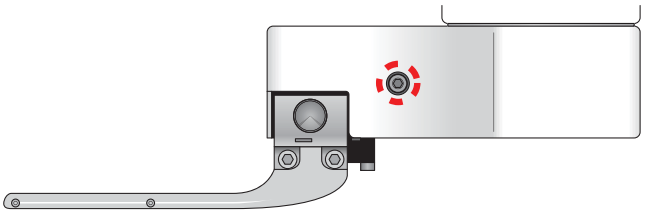
4 Click **Teach Mode.** The blue light on the robot hand turns on to indicate that it is in the teach mode. You should be able to move the robot arm without resistance.

IMPORTANT Always move the robot arm slowly when in the Teach Mode.

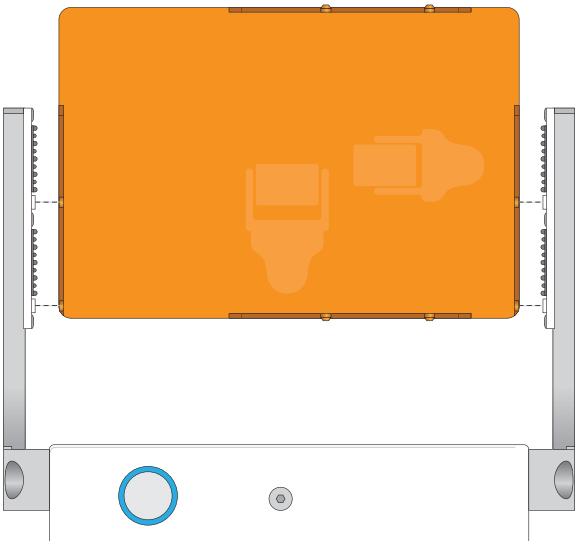


5 Manually move the robot arm to a position that will be convenient for you to install the teaching jig.

6 Using the 2-mm hex wrench, turn the gripper lead screw to open the robot grippers so that the teaching jig can fit in the grippers. You can access the lead screw from both sides of the robot hand.



7 Position the teaching jig between the robot grippers. Align the two pins on both sides of the teaching jig with the white dimples in the grippers. The following diagram shows the alignment positions in the landscape mode.



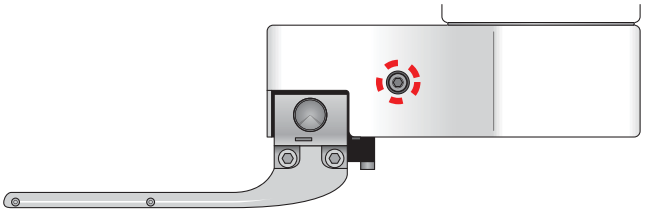
8 Using the 2-mm hex wrench, turn the gripper lead screw to close the robot grippers. The grippers should hold the teaching jig securely.

To remove the teaching jig:

1 While in the Teach Mode, manually move the robot arm to a position that will be convenient for you to remove the teaching jig. Make sure you move the robot slowly

2 Place a hand under the teaching jig to support its weight for the next step.

3 Using the 2-mm hex wrench, turn the gripper lead screw to open the robot grippers so that the teaching jig is free from the grippers.



Creating a new teachpoint

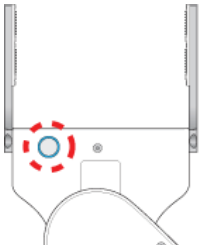
WARNING **Always wear protective eyewear when entering the system and working with the robot.**

CAUTION Do not set teachpoints within the safe zone. For information about the safe zone, see "Safe zone" on page 18.

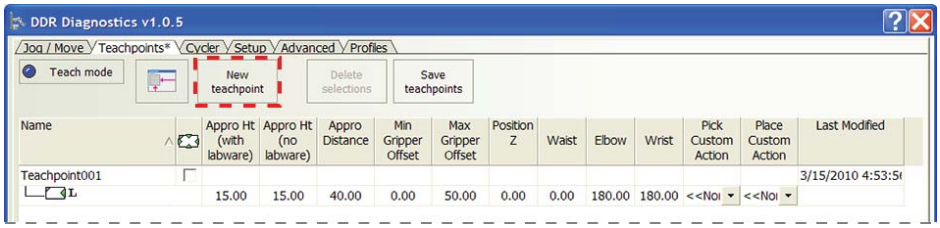
To create a teachpoint:

1. With the teaching jig in the robot grippers, slowly move the robot arm to the desired location. When moving the robot arm:
   a. Check for potential obstacles near the location.
   b. Keep in mind the "Guidelines for setting teachpoints" on page 82.
2. Position the teaching jig at the desired location. Make sure the teaching jig sits flat at the location.
3. Press the blue button on the robot hand. The blue light flashes for a moment. In the Teachpoints tab, a new entry appears.

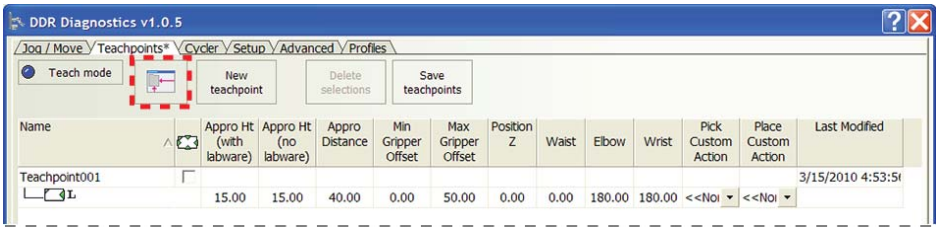
   Note: The blue light does not flash if the robot is at a location that is outside of its travel limits. Move the teachpoint location and try again.



If it is not possible to access the blue button on the robot hand, you can click the **New teachpoint** button in the **Teachpoints** tab.



4. To view the entire teachpoints table, click the (Maximize/Minimize) button. The table expands so that all of the columns are displayed in the tab.



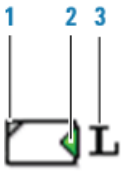
Naming the teachpoint

To name the teachpoint:

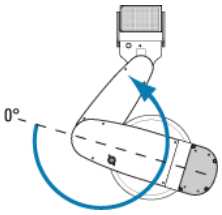
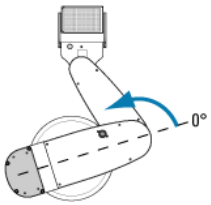
Double-click the **Name** box and type a new name for the teachpoint. Use a name that describes the location, such as the device name (for example, PlateLoc - 1).

Specifying the A1-well orientation

The icon under the teachpoint name indicates the following:

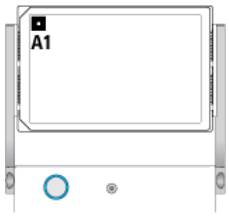
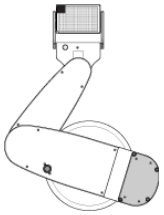
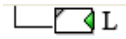
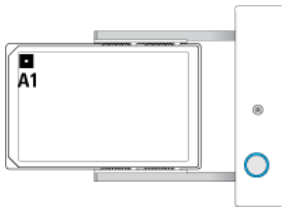
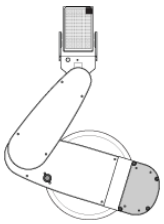
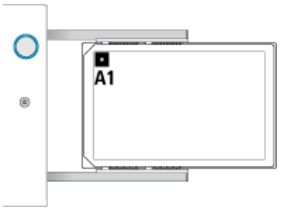
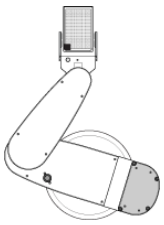
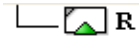
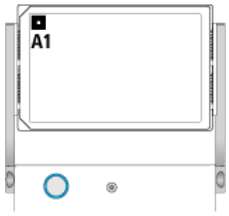
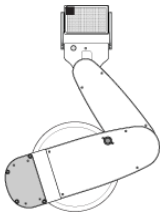


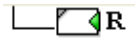
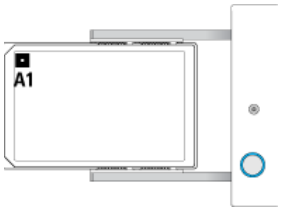
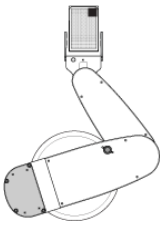
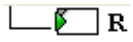
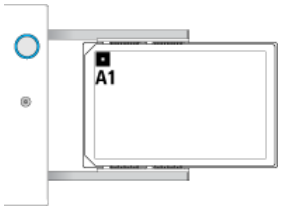
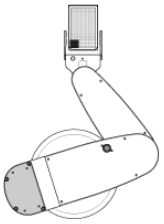
Item	Description
1	A1-well orientation. From the robot's perspective, the A1 well (the gray corner on the icon) can be: • *Away from the robot grippers.* or • *Toward the robot grippers.* or The robot cannot detect the location of the A1 well. Therefore, you must provide this information in the software. ***To change the A1-well orientation:*** Double-click the icon. The robot gripper symbol (green triangle) moves to the opposite side of the labware. *Note:* The robot is unaware of the A1-well orientation assignment. Changing it in the software does not automatically or physically change the way the robot holds the labware.
2	Labware orientation. The location of the green robot gripper symbol determines the orientation: • *Landscape.* or • *Portrait.* or *Note:* You cannot change the labware orientation. The software uses the gripper width to determine whether it is in the landscape or portrait mode.

Item	Description
3	Robot-arm orientation: Left (L)  or right (R)  *Note:* You cannot change the robot arm orientation. The software uses the elbow joint angle to determine whether it is in the left- or right-arm mode. A right arm has an elbow joint angle < 180°. A left arm has an elbow joint angle of >= 180°.

Common orientations

Eight orientations are possible for each teachpoint, based on different A1-well, labware, and robot-arm orientations. The following table presents six common orientations.

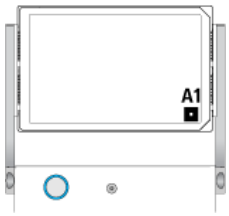
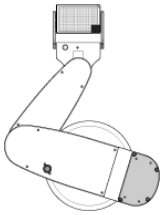
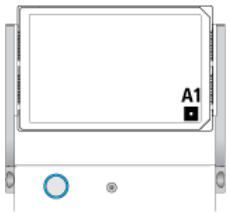
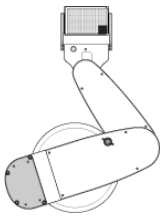
Orientation icon	Labware orientation	Robot arm orientation
		
		
		
		

Orientation icon	Labware orientation	Robot arm orientation
		
		

Atypical orientations

The following table presents two atypical orientations. These orientations are used only when:

- Devices, such as the FLIPR Tetra device, require the A1 well to be toward the grippers.
- Two robots in the same system will use a single location to pass labware. One robot will approach the teachpoint using a common orientation (for example, landscape and A1 away), the other robot will approach the same teachpoint from the opposite side, using an atypical orientation (for example, landscape and A1 toward).

Orientation icon	Labware orientation	Robot arm orientation
		
		

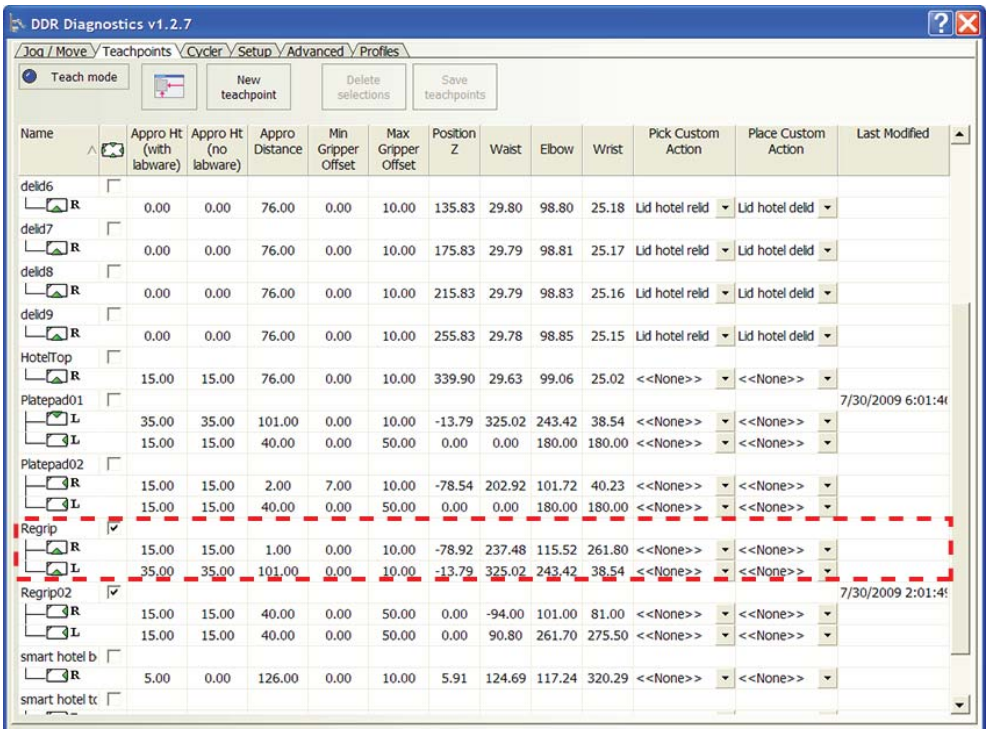
Designating a teachpoint as a regrip station

A regrip station is a location that enables the robot to:

- Change the labware orientation between teachpoints that require different orientations (landscape or portrait).
- Change A1-well orientation between teachpoints that require different A1-well orientations.
- Adjust its grip at the specified labware gripping height. The location is typically used after a robot picks up a labware higher than the specified gripping height because of physical restrictions at a teachpoint.

Note: Regrip stations cannot be used for other purposes such as deadlock avoidance.

To accommodate different labware orientations, add multiple orientations to the regrip teachpoint. In the following example, the Regrip teachpoint accommodates both the right- and left-arm orientations, with the landscape labware orientation and the A1 well away from the grippers.



To designate a teachpoint as a regrip station:

Select the **Regrip Station** check box.

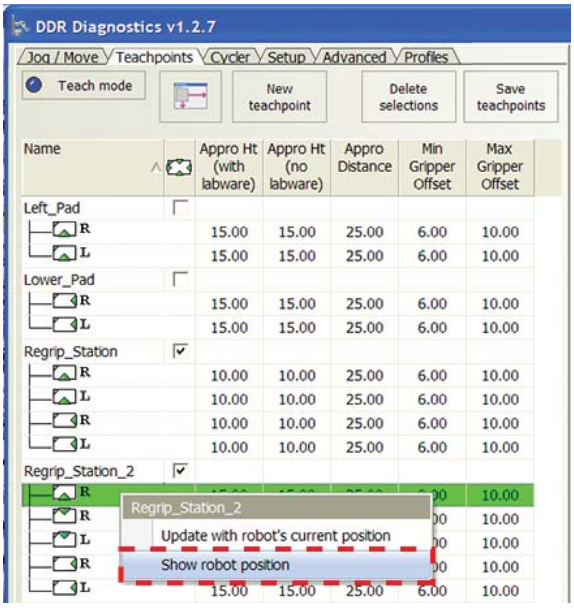
CAUTION Changes to a regrip station (from a regular teachpoint to a regrip station or from a regrip station to a regular teachpoint) are not applied until you save the teachpoint file.

To add additional orientations to the regrip teachpoint:

1. Create another teachpoint at the same location but with a different orientation. A new entry appears in the teachpoints table.
2. If necessary, set the A1-well orientation.

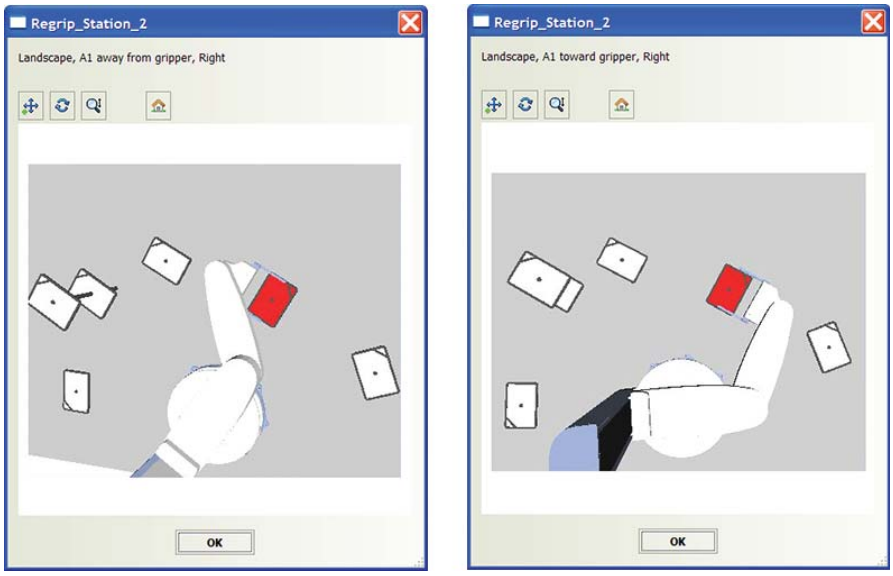
By default, a new teachpoint will always have the A1-away orientation. When adding multiple teachpoints at a regrip station, if two of the teachpoints have the same labware and robot-arm orientation, and it is difficult to tell which one should have the A1-well away or toward assignment unless you see the actual robot position:

a Right-click the teachpoint in the teachpoints table, and then click **Show robot position.**



b In the dialog that appears, check the robot position, and the robot-arm and A1-well orientations.

In the following example, two teachpoints have the same labware and robot-arm orientations: landscape and right-arm. However, depending on the robot approach, the A1-well orientation will be different.



c Click **OK** to exit the dialog box and, if necessary, set or correct the A1-well orientation setting.

3 Drag the new teachpoint under an existing regrip teachpoint.

CAUTION The new teachpoint must have a different orientation than the existing regrip teachpoint. Otherwise, the software will prompt you to replace or reteach the existing teachpoint during the drag-and-drop operation.

4 Set the remaining teachpoint parameters.

Setting the approach height

Approach height is the height clearance, in millimeters, the robot must maintain above the teachpoint as it moves towards or away from the teachpoint.

- Approach Ht (with labware) is the height clearance when the robot is holding a labware.
- Approach Ht (no labware) is the height clearance when the robot is not holding labware.

You can reduce the approach height to prevent collision with shelves or other obstacles above the teachpoint. However, make sure there is sufficient clearance below the labware to prevent collision with raised tabs or other obstacles at the teachpoint.

CAUTION Incorrect approach heights can cause the robot to crash into obstacles.

IMPORTANT The approach height value works in conjunction with the approach distance to clear obstacles near or at the teachpoint. Therefore, before setting the approach height value, you should determine the approach distance value to use. See "Setting the approach distance" on page 100.

If Approach Distance is set at the default value:

- The Approach Ht (with labware) value should allow the robot and labware to arrive at the teachpoint without bumping into any obstacles, such as raised tabs, at the front of the teachpoint.
- The Approach Ht (no labware) value should allow the robot and its opened grippers to arrive at the teachpoint without bumping into any obstacles, such as raised tabs, at the sides of the teachpoint.

  Note: If the teachpoint does not have any obstacles on the front or sides, you can set Approach Ht (no labware) at 0. The robot will approach the teachpoint at the higher of the teachpoint or labware minimum gripper offset value.

If Approach Distance is less than the default value:

- The Approach Ht (with labware) value should allow the robot and labware to arrive at the teachpoint without bumping into obstacles, such as raised tabs, at the front and sides of the teachpoint.
- The Approach Ht (no labware) value should allow the robot and its opened grippers to arrive at the teachpoint without bumping into the tallest labware at the teachpoint.

In general, if a teachpoint has raised tabs only at the front of the teachpoint, the Approach Ht (with labware) value should be greater than the Approach Ht (no labware) value.

Agilent Technologies recommends the following Approach Ht (with labware) values:

Device	Approach Ht (with labware)
Most devices	9 mm
Vertical Pipettor shelf with tipbox	6 mm
Centrifuge	5.5 mm
Plate Hub Carousel Carousel or Plate Hotel with standard labware	5–6 mm
Lid Hotel Station	0 mm*
Vacuum Delid Station	0 mm*

* Required approach height for the device

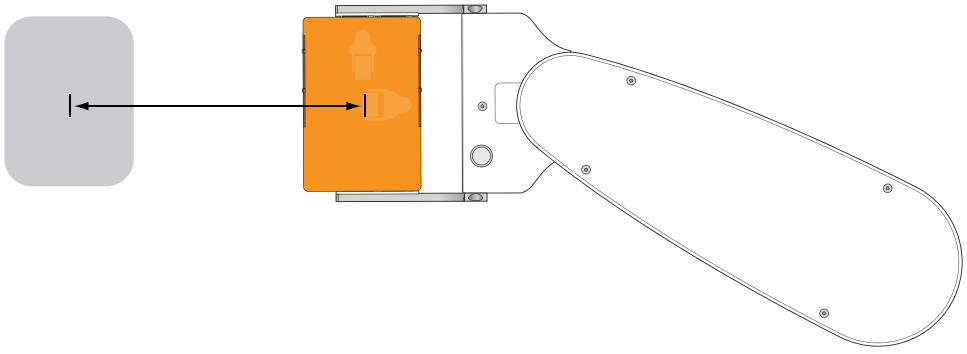
To set the Approach Ht (with labware) and Approach Ht (no labware) parameters:

Double-click in the **Approach Ht** box and type the desired value. The default value for both parameters is 15 mm.

Setting the approach distance

Approach distance is the distance, in millimeters, from the teachpoint. Within this distance, the robot must:

- Maintain the specified approach height.
- Move in a straight line toward or away from the teachpoint.



You use the approach distance to provide clearance:

- Between the teachpoint and the robot grippers.
- If the teachpoint has obstacles on either side of the teachpoint.

For example, you can use the approach distance parameter so that the robot grippers can enter and exit a device such as the Microplate Centrifuge without bumping into the sides of the narrow entryway.

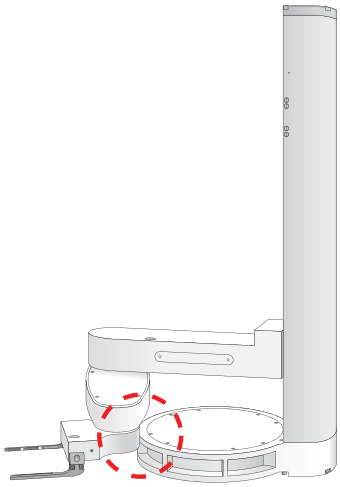
When determining the value to specify, manually move the robot away from the teachpoint until the grippers and the teaching jig are clear of the edge of the teachpoint and obstacles near the teachpoint.

In addition, consider the following:

- In general, if Approach Distance is set at the default value, you can use the default Approach Ht values.
- Rotating robot movements are faster than straight movements. If Approach Distance is set at 0, the robot will move (or mostly rotate) from the safe zone directly to the teachpoint at the Approach Ht.

  Before setting Approach Distance at 0, you should consider the obstacles surrounding and at the teachpoint. If obstacles near or at the teachpoint do not permit the rotating movement, set Approach Distance at the smallest possible value for the location.
- If Approach Distance is 0, Approach Ht (no labware) must be a higher value to ensure clearance for the tallest labware that will be placed at the teachpoint.
- If Approach Distance is greater than 0, Approach Ht can be low enough to clear raised tabs at the teachpoint.

CAUTION When setting Approach Distance, be aware that a large value can cause the robot arm to back into the raised robot base or the mast.



To set the Approach Distance parameter:

Double-click in the **Approach Distance** box and type the desired value. The default value is 75 mm for the landscape orientation and 125 mm for the portrait orientation.

Setting the gripper offset parameters

About gripper offset parameters

The robot gripper offset range parameters tell the Direct Drive Robot where to grip a given labware type when transferring it from one device to another. Each device within a system can pose different accessibility challenges when transferring the labware. For example, some devices can have a deep, recessed area, whereas others are more flat. Some devices might have tall flanges that make it impossible for the robot to grip a microplate at a very low point.

The Direct Drive Robot uses three types of gripper offset ranges to determine the most compatible grip position for the labware type:

1. *Gripper offset range for the labware*. Specified on the Direct Drive Robot tab in the Labware Editor for each labware definition.
2. *Gripper offset range for pick-location device*. Specified in the DDR Diagnostics software for a given device (device A).
3. *Gripper offset range for place-location device*. Specified in the DDR Diagnostics software for a given device (device B).

If the three gripper offset ranges overlap, the robot will use the smallest common gripper offset to perform a direct labware transfer from device A to device B without regripping the labware. If the three ranges do not overlap, the software attempts to plan a path through one or more regrip stations. If the robot cannot perform the transfer, an error message appears at the time of the requested labware transfer.

To provide the system with the greatest flexibility for identifying a grip position that works for all locations, you should set the widest possible range for each gripper offset parameter.

Note: To catch and correct potential labware transfer errors, Agilent Technologies recommends that you verify the teachpoints and perform a dry run.

Before you set the gripper offset parameters

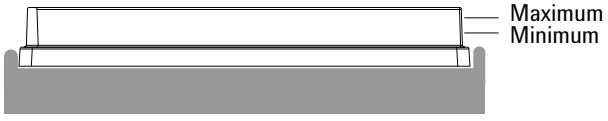
Under some circumstances, you should consider the gripper offset ranges of more than two teachpoints to avoid a regrip. For example, a labware will be delidded as it moves from the pick location (device A) to the place location (device B). In this case, the gripper offset range for the delid teachpoint must also overlap with the gripper offset range for the labware, device A, and device B.

Procedure

To set the Min gripper offset and the Max gripper offset parameters for a device:

Double-click the **Min gripper offset** and **Max gripper offset** box and type the desired values:

- *Minimum gripper offset*. The vertical distance (mm) from the teachpoint to the lowest point where the robot grippers can hold the microplate securely. The default value is 0 mm.
- *Maximum gripper offset*. The vertical distance (mm) from the teachpoint to the highest point where the robot grippers can hold the microplate securely. The default value is 10 mm.



IMPORTANT For regrip stations, make sure the gripper offset range can accommodate all types of labware.

Setting the Position Z, Waist, Elbow, and Wrist parameters

CAUTION In general, you do not need to change any of the coordinates after setting a teachpoint.

If necessary, you can fine-tune the teachpoint coordinates using the following parameters:

- *Position Z*. The *z*-axis coordinate of the robot, measured in millimeters.
- *Waist*. The waist joint coordinate.
- *Elbow*. The elbow joint coordinate.
- *Wrist*. The wrist joint coordinate.

To set a coordinate parameter:

Double-click in the **Position Z**, **Waist**, **Elbow**, and **Wrist** box and type the desired value.

Note: You can also use the jog method when fine-tuning. For instructions, see "Editing existing teachpoints" on page 121.

Selecting custom actions

Custom actions are special pick-and-place actions that the robot will perform after it arrives at the teachpoint. The set of custom actions include:

- Delidding at a Lid Hotel Station or a Vacuum Delid Station
- Relidding at a Lid Hotel Station
- Stirring the labware
- Pressing down a labware (for example, PCR plate) to ensure placement

You can select a custom action for any teachpoint.

To select a custom action for a teachpoint:

1 Select the appropriate action from the **Pick Custom Action** list.

Use the Pick Custom Action to:

- Relid labware at the Lid Hotel Station. From the **Pick Custom Action** list, select **Lid Hotel relid.**

  Note: You can select a custom action for each storage bay in the Lid Hotel Station. Do not assign a custom action for the platepad at the top of the station.

- Stir the labware at the teachpoint. From the **Pick Custom Action** list, select **Stir.**

2 Select the appropriate action from the **Place Custom Action** list.

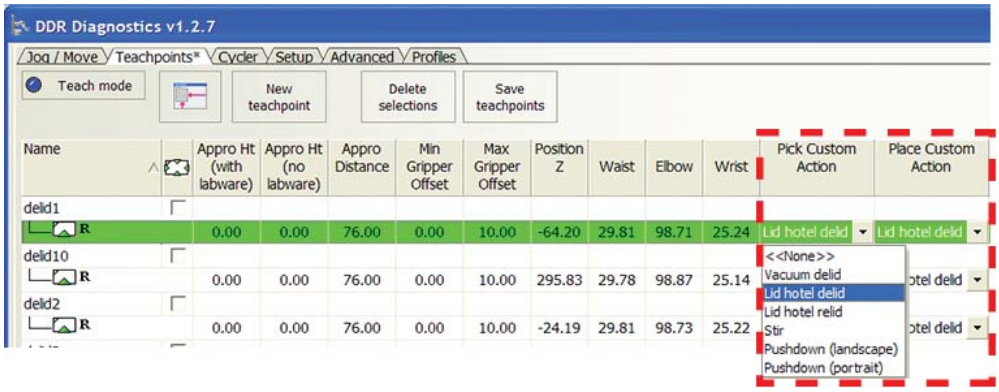
Use the Place Custom Action to:

- Delid labware at the Lid Hotel Station or the Vacuum Delid Station. From the **Place Custom Action** list, select either **Lid Hotel delid** or **Vacuum delid.**

  Note: You can select a custom action for each storage bay in the Lid Hotel Station. Do not assign a custom action for the platepad at the top of the station.

- Press down labware, such as a PCR plate, when the robot is placing the labware. During the place action, the robot will press down by 2 mm, open the grippers to release the labware, and then move up by 2 mm.

  From the **Place Custom Action** list, select either **Pushdown (landscape)** or **Pushdown (portrait).**



Saving the teachpoints

The teachpoint information is stored in:

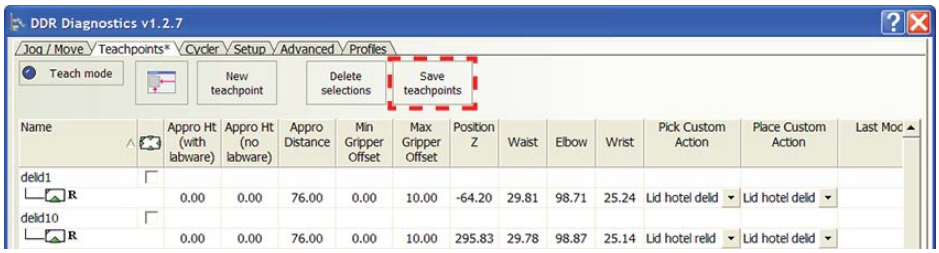
- The teachpoints file on the controlling computer
- The robot firmware

When you create or modify teachpoints without saving them, the changes are kept in computer memory only. Saving the teachpoints in DDR Diagnostics updates the teachpoints file and the information in the firmware.

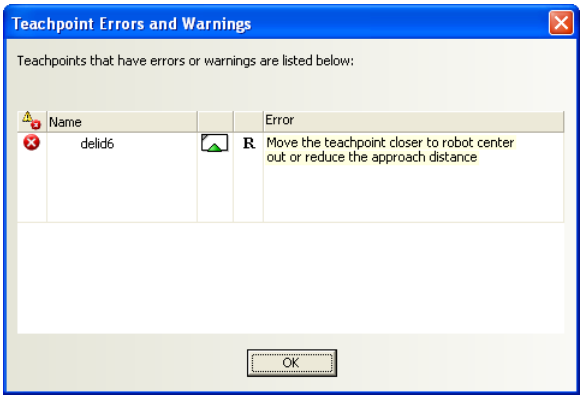
Note: Saving teachpoints adds new teachpoints or updates only those teachpoints that have been modified in DDR Diagnostics. Saving teachpoints does not overwrite all of the existing teachpoints. For example, a teachpoint file contains teachpoints A and B. You modify teachpoint B and add teachpoint C. When you save the teachpoints, teachpoint C is added, and teachpoint B is updated. Teachpoint A is not touched.

To save the teachpoints:

1 Click **Save teachpoints.**

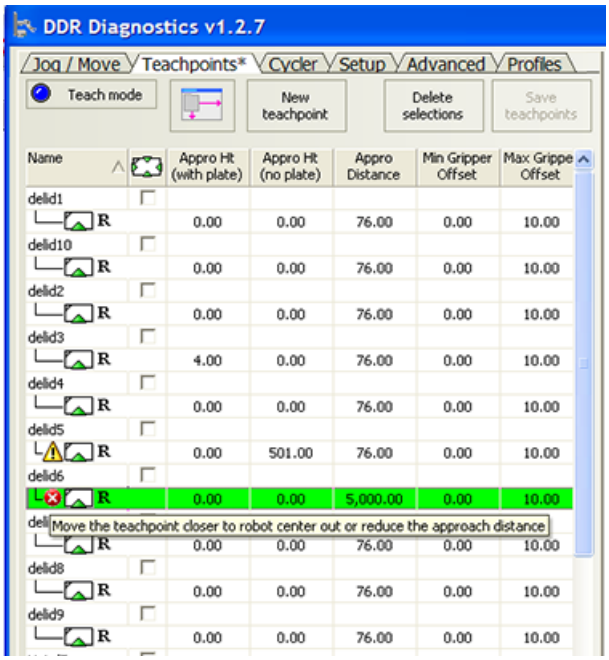


If there are any errors or warnings, such as an out-of-bounds parameter value, the software will list them in the Teachpoint Errors and Warnings dialog box.


Teachpoint Errors and Warnings
Teachpoints that have errors or warnings are listed below:
Name
Error
delid6
Move the teachpoint closer to robot center out or reduce the approach distance
OK

2 Click **OK** to close the dialog box and return to the teachpoints table. Notice that error and warning symbols appear in the teachpoints table.

3 To display the error or warning message, rest the pointer on the error or warning symbol.



4 Fix the errors, and then click **Save teachpoints.**

Be sure to remove the teaching jig from the robot grippers when you are finished. See "Installing and removing the teaching jig in the robot grippers" on page 90.

Selecting the All regrip stations are safe from above option

The **All regrip stations are safe from above** option enables the robot to rotate its wrist above the regrip station while it prepares to change labware orientation.

If the option is selected, the robot will place the labware at the regrip station, lift its arm to the specified Approach Ht (no labware) distance above the regrip station, rotate its wrist, and then pick up the labware using the new orientation. The robot does not retreat into the safe zone during this process.

If the option is not selected, the robot will place the labware at the regrip station, retreat into the safe zone, and then pick up the labware at the regrip station using the new labware orientation. The specified Approach Ht and Approach Distance values are used during the retreat and pickup movements.

After you have finished setting all the teachpoints, review the list in the teachpoints table. You can select the **All regrip stations are safe from above** option in the Profiles tab if:

- There is at least one regrip station that is used to change labware orientations.
- There is sufficient clearance above *all* regrip stations to permit the robot to rotate its wrist during a labware orientation regrip process.

To see where you select this option in the Profiles tab, see "Creating Direct Drive Robot profiles" on page 56.

Related information

For information about...	See...
Robot Diagnostics	"Software overview" on page 11
Direct Drive Robot axes	"About the Direct Drive Robot" on page 2
Quick reference of DDR Diagnostics commands and parameters	"Quick reference" on page 219

Setting teachpoints using a labware

When to use labware instead of the teaching jig

In cases where size restriction at a teachpoint prevents the use of the teaching jig, you can use the labware intended for the location.

Procedure

WARNING **Always wear protective eyewear when entering the system and working with the robot.**

To use a labware in the teaching procedure:

1 Teach a reference location, such as Platepad 1, using the teaching jig.

IMPORTANT When teaching the reference location, make sure the Min gripper offset parameter value is less than or equal to the minimum gripper offset value specified for the labware in the Labware Editor.

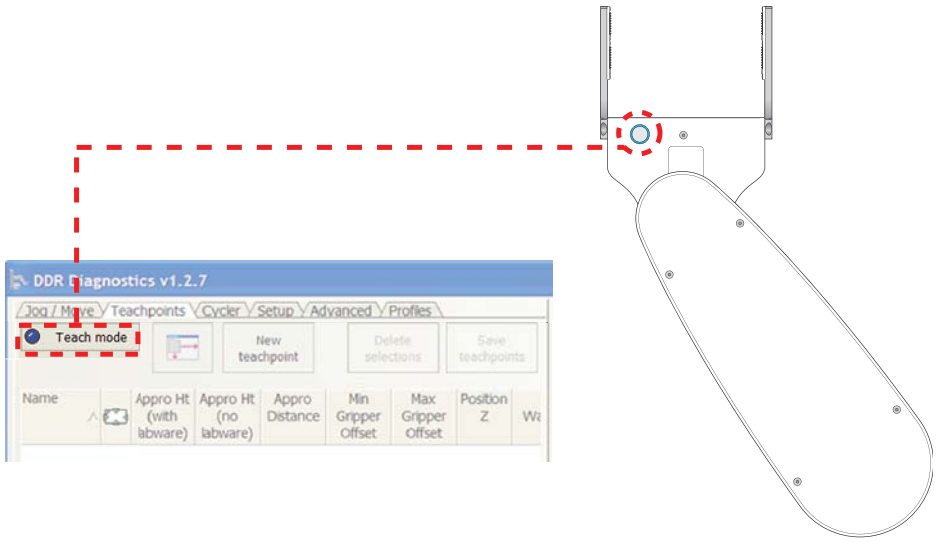
CAUTION When using a labware to set teachpoints, the software assumes that the robot is holding the labware at the minimum gripper offset.

2 Verify the Platepad 1 teachpoint.

3 Place the desired labware at Platepad 1.

4 Follow the instructions in "Picking up labware at the teachpoint" on page 112 to pick up the labware from Platepad 1.

5 In DDR Diagnostics, click **Teach Mode.** The blue light on the robot hand turns on to indicate that it is in the teach mode. You should be able to move the robot arm without resistance. Make sure you move the robot slowly.



6 Follow the instructions in “Creating a new teachpoint” on page 93 to create a new teachpoint.

7 Set the teachpoint parameters.

8 Save the teachpoint.

9 Verify and edit the teachpoint.

Related information

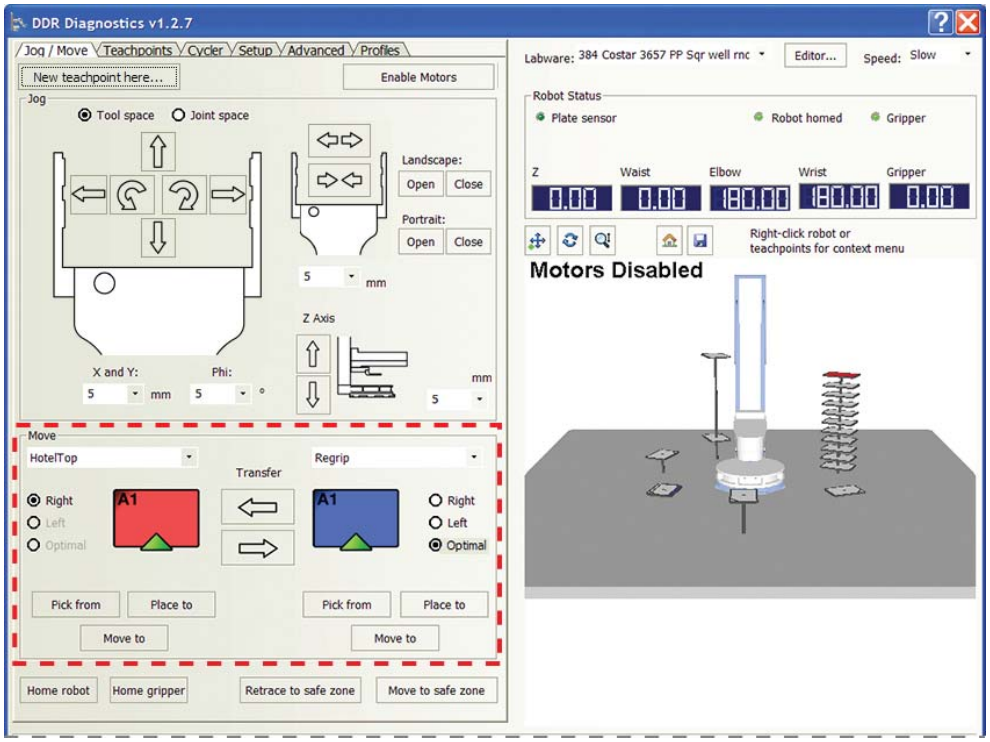
For information about...	See...
Workflow for setting teachpoints	“Workflow” on page 89
Using other commands and parameters in the DDR Diagnostics	“Using DDR Diagnostics” on page 137
Quick reference of DDR Diagnostics commands and parameters	“Quick reference” on page 219

Verifying teachpoints

After you set a new teachpoint, you should verify that it is accurate by:

- Moving the robot to the new teachpoint
- Picking up labware at the teachpoint
- Placing labware at the teachpoint
- Transferring labware between two teachpoints

You use the commands in the **Jog/Move** tab for the verification procedure.



Moving the robot to the new teachpoint

You use the **Move to** command to check that:

- The robot is able to move to the selected teachpoint.
- The approach orientation at the teachpoint is correct.

WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

WARNING **Stay out of the system while the robot is in motion.**

To move the robot to the teachpoint:

1 Make sure the robot has a clear path to the teachpoint. For example, you might want to move the robot into the safe zone.

2 Remove obstacles in the path of the robot.

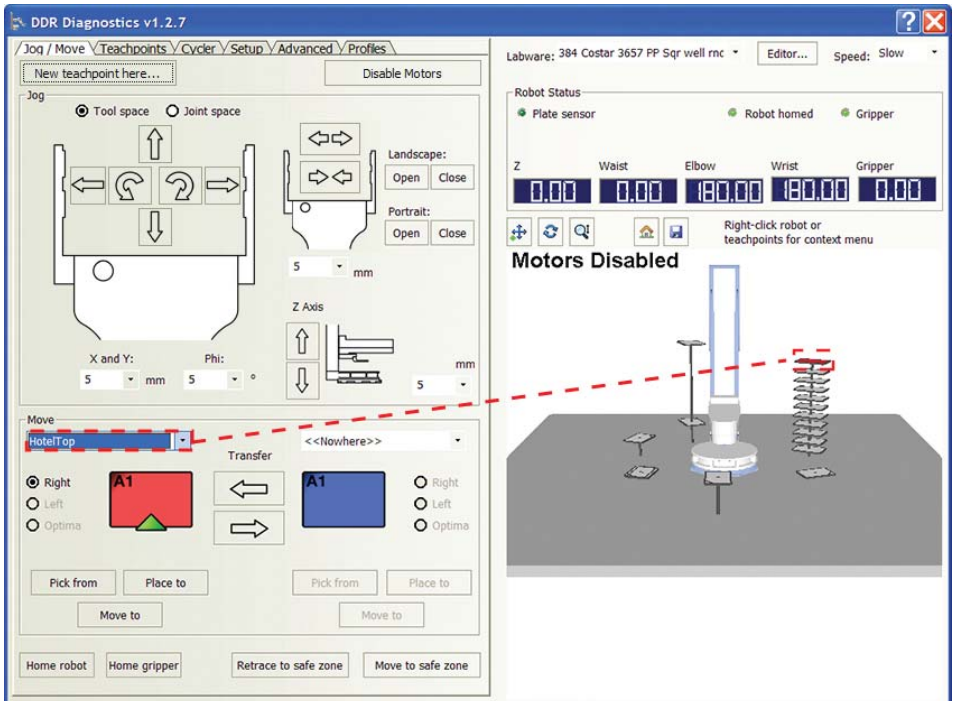
3 In **DDR Diagnostics,** make sure the correct labware is selected in the **Labware** list.

4 In the **Speed** list, select **Slow.**

5 Click the **Jog/Move** tab, and, if necessary, click **Enable Motors** to enable the robot motors.

6 In the **Move** area, select the teachpoint you want to verify from the list above the red labware. In the Robot Status area, the selected teachpoint turns red.

In the following example, the HotelTop teachpoint is selected. In the Robot Status area, the teachpoint at the top of the Plate Hotel becomes red.



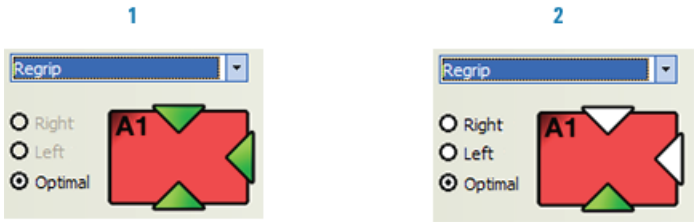
7 If you selected a teachpoint with multiple orientations, such as a regrip station, select the specific set of orientations you want to verify.

Note: By default, all orientations defined for the teachpoint are selected.

- If multiple labware orientations are available, make sure only one orientation is selected. Click a triangle to select or clear the orientation selection. A green triangle means the orientation is selected. A white triangle means the orientation is not selected.

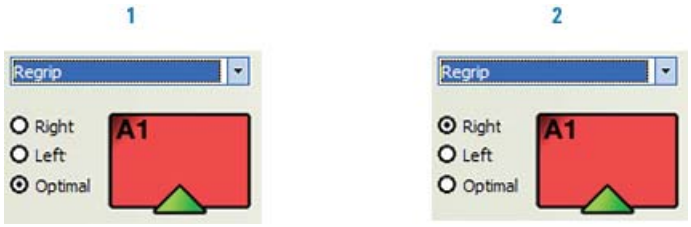
  In the following example, three labware orientations are available: Landscape with the A1 well away from the grippers, landscape with the A1 well toward the grippers, and portrait with the A1 well away

from the grippers (1). For the verification procedure, only one orientation is selected: Landscape with the A1 well away from the grippers (2).



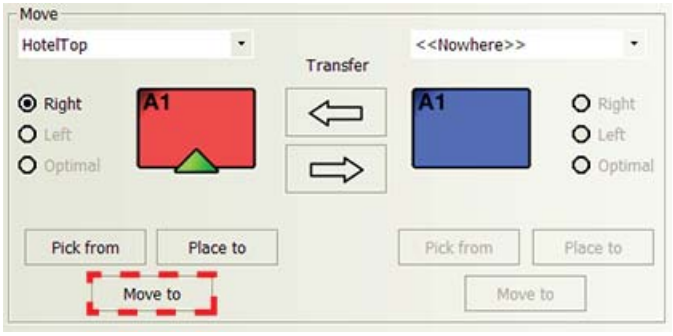
- If the Optimal orientation is selected to indicate that both the right-arm and left-arm orientations are available, select **Right** or **Left**.

  In the following example, the Regrip station allows for both the right- and left-arm orientations (1). To verify the right-arm orientation, Right is selected (2).

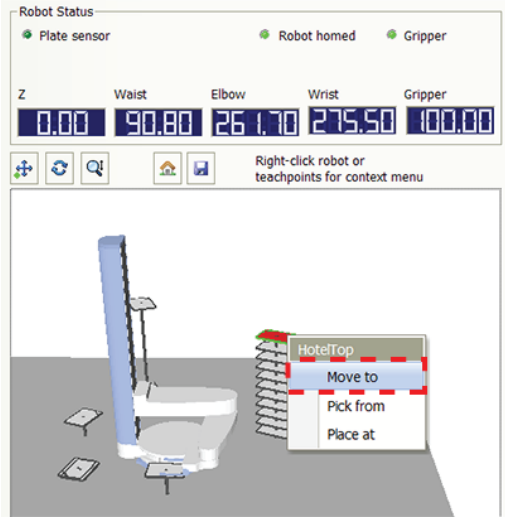


Agilent Technologies recommends that you verify one set of orientations at a time. If multiple sets of orientations are selected, the robot will use the optimal path.

8 In the **Move** area, click **Move to** under the red labware.



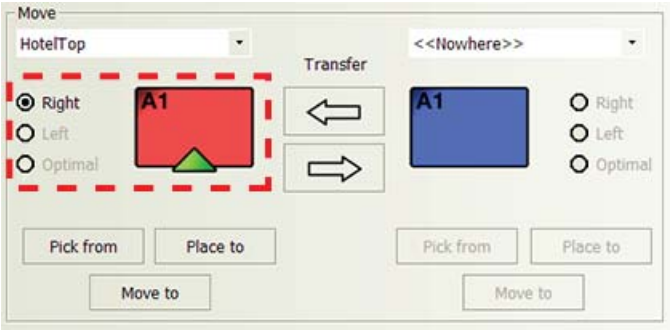
Alternatively, you can right-click the red teachpoint in the **Robot Status** area, and then click **Move to.**



The robot moves to the selected teachpoint. The robot remains at the teachpoint and the grippers are open.

9 Check that the robot used the correct approach distance and approach height. In addition, make sure the robot is in the correct orientation as shown in the Move area.

In the following example, the robot should be in the right-arm mode and the grippers should be opened as if it was transferring a labware in the landscape orientation.



10 To make adjustments, proceed to "Editing existing teachpoints" on page 121.

11 Repeat the procedure for another teachpoint. If you are verifying a teachpoint with multiple orientations, be sure to verify each orientation before checking another teachpoint.

Picking up labware at the teachpoint

You use the **Pick from** command to check that:

- The robot is using the correct approach distance and approach height as it moves to and from the teachpoint.
- The robot is able to pick up labware at the selected teachpoint.
- The robot picks up the labware within the specified gripper offset range.

WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

WARNING **Stay out of the system while the robot is in motion.**

To pick up labware from the teachpoint:

1. Make sure the robot has a clear path to the teachpoint. For example, you might want to move the robot into the safe zone.
2. Remove obstacles in the path of the robot.
3. Manually place the labware at the teachpoint.
4. In **DDR Diagnostics,** select the labware you want to use from the **Labware** list.

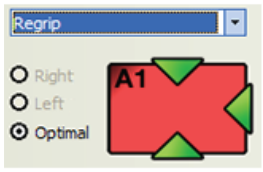
5. In the **Speed** list, select **Slow.**
6. In the **Move** area, select the teachpoint you want to verify from the list above the red labware. In the Robot Status area, the selected teachpoint turns red.
7. If you selected a teachpoint with multiple orientations, such as a regrip station, select the specific set of orientations you want to verify.

   Note: By default, all orientations defined for the teachpoint are selected.

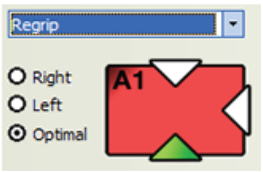
   - If multiple labware orientations are available, make sure only one orientation is selected. Click a triangle to select or clear the orientation selection. A green triangle means the orientation is selected. A white triangle means the orientation is not selected.

     In the following example, three labware orientations are available: Landscape with the A1 well away from the grippers, landscape with the A1 well toward the grippers, and portrait with the A1 well away from the grippers (1). For the verification procedure, only one orientation is selected: Landscape with the A1 well away from the grippers (2).

1

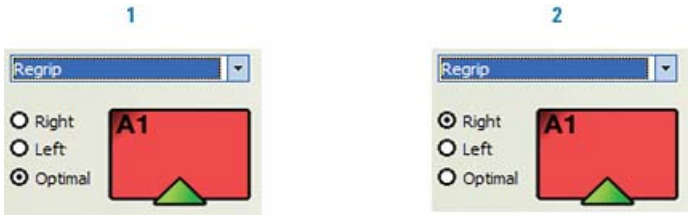


2



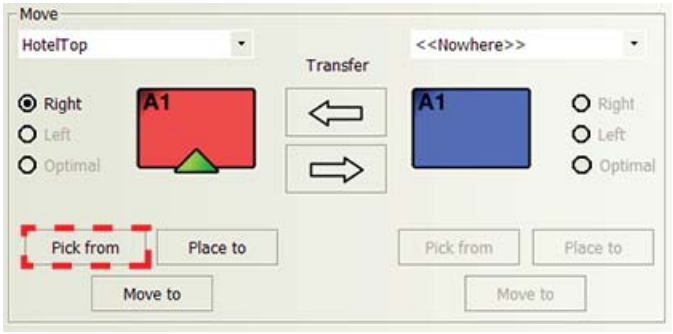
- If the Optimal orientation is selected to indicate that both the right-arm and left-arm orientations are available, select **Right** or **Left**.

  In the following example, the Regrip station allows for both the right- and left-arm orientations (1). To verify the right-arm orientation, Right is selected (2).

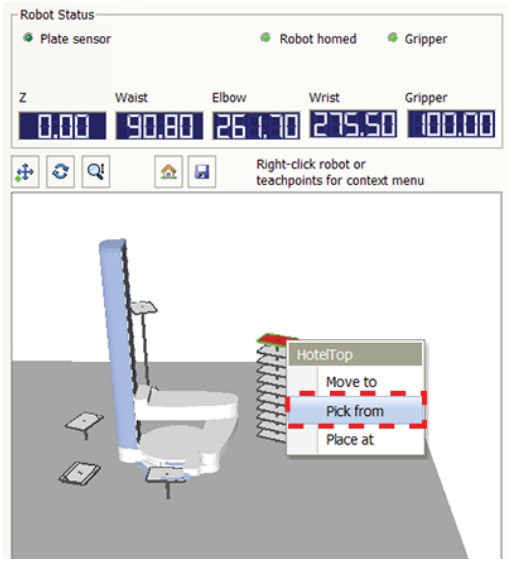


Agilent Technologies recommends that you verify one set of orientations at a time. If multiple sets of orientations are selected, the robot will use the optimal path.

8 In the **Move** area, click **Pick from** under the red labware.



Alternatively, you can right-click the red teachpoint in the **Robot Status** area, and then click **Pick from.**



The robot moves to the teachpoint, picks up the labware, and moves it to the safe zone. The labware remains in the robot grippers.

9 Check that the robot used the correct approach distance and approach height when picking up the labware. Also check that the robot is holding the labware within the specified gripper offset range.

10 To make adjustments, proceed to "Editing existing teachpoints" on page 121.

11 If the robot has completed its task correctly, repeat the procedure for another teachpoint. If you are verifying a teachpoint with multiple orientations, be sure to verify each orientation before checking another teachpoint.

Placing labware at the teachpoint

You use the **Place to** command to check that:

- The robot is using the correct approach distance and approach height as it moves to and from the teachpoint.
- The robot is able to place the selected labware at the selected teachpoint.

WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

WARNING **Stay out of the system while the robot is in motion.**

IMPORTANT To use the Place to command, you must first use the Pick from command to pick up a labware so that the gripper offset is known.

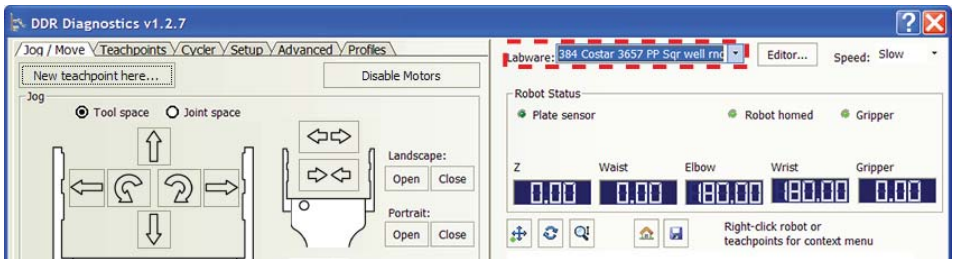
To place labware at the teachpoint:

1 Make sure the robot has a clear path to the teachpoint. For example, you might want to move the robot into the safe zone.

2 Remove obstacles in the path of the robot.

3 Make sure the robot is still holding the labware from the previous procedure ("Picking up labware at the teachpoint" on page 112).

4 In **DDR Diagnostics,** make sure the correct labware is selected in the **Labware** list.



5 In the **Speed** list, select **Slow.**

6 In the **Move** area, select the teachpoint you want to verify from the list above the red labware. In the Robot Status area, the selected teachpoint turns red.

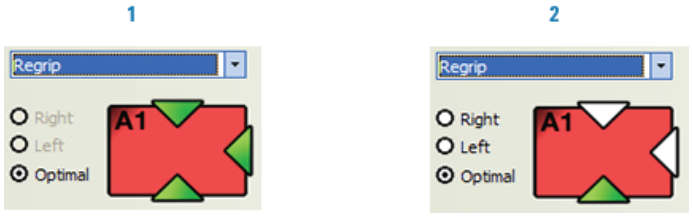
Note: Alternatively, you can select the teachpoint under the blue labware. In the Robot Status area, the selected teachpoint turns blue.

7 If you selected a teachpoint with multiple orientations, such as a regrip station, select the specific set of orientations you want to verify.

Note: By default, all orientations defined for the teachpoint are selected.

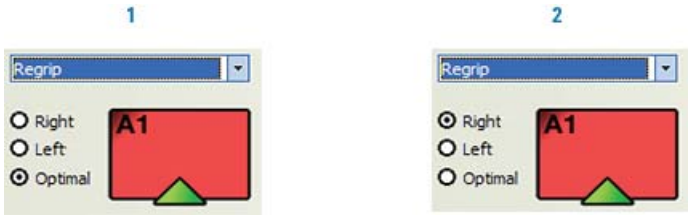
- If multiple labware orientations are available, make sure only one orientation is selected. Click a triangle to select or clear the orientation selection. A green triangle means the orientation is selected. A white triangle means the orientation is not selected.

  In the following example, three labware orientations are available: Landscape with the A1 well away from the grippers, landscape with the A1 well toward the grippers, and portrait with the A1 well away from the grippers (1). For the verification procedure, only one orientation is selected: Landscape with the A1 well away from the grippers (2).



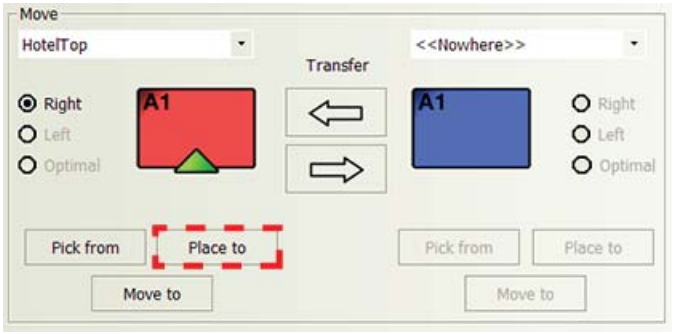
- If the Optimal orientation is selected to indicate that both the right-arm and left-arm orientations are available, select **Right** or **Left**.

  In the following example, the Regrip station allows for both the right- and left-arm orientations (1). To verify the right-arm orientation, Right is selected (2).

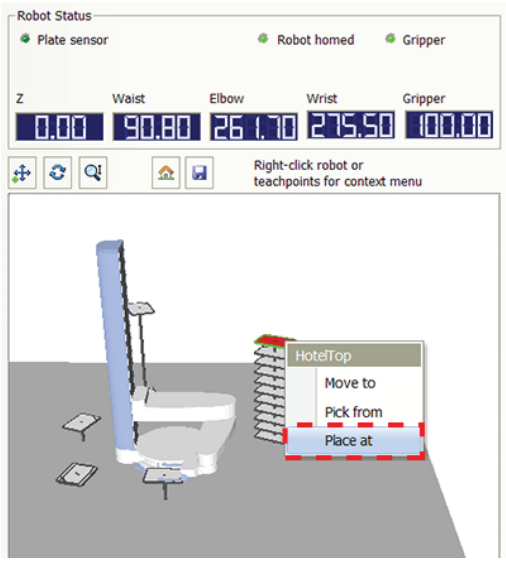


Agilent Technologies recommends that you verify one set of orientations at a time. If multiple sets of orientations are selected, the robot will use the optimal path.

8 In the **Move** area, click **Place to** under the red labware.



Alternatively, you can right-click the red teachpoint in the **Robot Status** area, and then click **Place at.**



With the labware in its grippers, the robot moves to the teachpoint, places the labware, and retreats to the safe zone.

9 Check that the robot used the correct approach distance and approach height when placing the labware. Also, check that the robot seated the labware correctly at the teachpoint. The robot should not drop the labware, and the labware should be centered at the teachpoint.

10 To make adjustments, proceed to "Editing existing teachpoints" on page 121.

11 Repeat the procedure for another teachpoint. If you are verifying a teachpoint with multiple orientations, be sure to verify each orientation before checking another teachpoint.

Transferring labware between two teachpoints

To ensure that a new teachpoint is accurate, check that the robot is able to transfer labware between the new teachpoint and an existing verified teachpoint. Incorrectly placed labware indicates that the teachpoint coordinates are incorrect.

WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

WARNING **Stay out of the system while the robot is in motion.**

To transfer labware from an existing verified teachpoint:

1 Make sure the robot has a clear path to the teachpoint. For example, you might want to move the robot into the safe zone.

2 Remove obstacles in the path of the robot.

3 Manually place the desired labware at the existing verified teachpoint (for example, platepad 1).

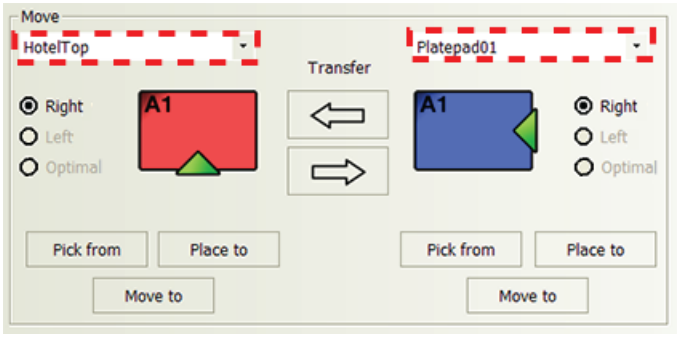
4 In **DDR Diagnostics,** select the labware you want to use from the **Labware** list.

5 In the **Speed** list, select **Slow.**

6 In the **Move** area:

a Select the teachpoint you want to verify from the list above the red labware. In the Robot Status area, the selected teachpoint turns red.

b Select the existing verified teachpoint (for example, platepad 1) from the list above the blue labware. In the Robot Status area, the selected teachpoint turns blue.



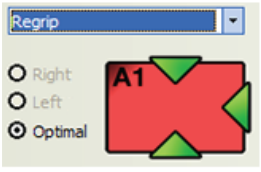
7 If you selected a teachpoint with multiple orientations, such as a regrip station, select the specific set of orientations you want to verify.

Note: By default, all orientations defined for the teachpoint are selected.

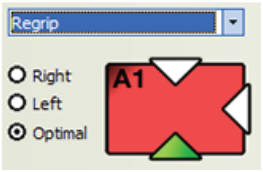
- If multiple labware orientations are available, make sure only one orientation is selected. Click a triangle to select or clear the orientation selection. A green triangle means the orientation is selected. A white triangle means the orientation is not selected.

  In the following example, three labware orientations are available: Landscape with the A1 well away from the grippers, landscape with the A1 well toward the grippers, and portrait with the A1 well away from the grippers (1). For the verification procedure, only one orientation is selected: Landscape with the A1 well away from the grippers (2).

1

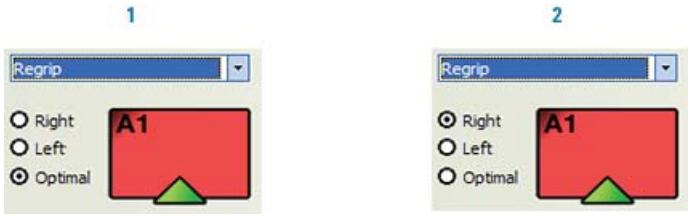


2



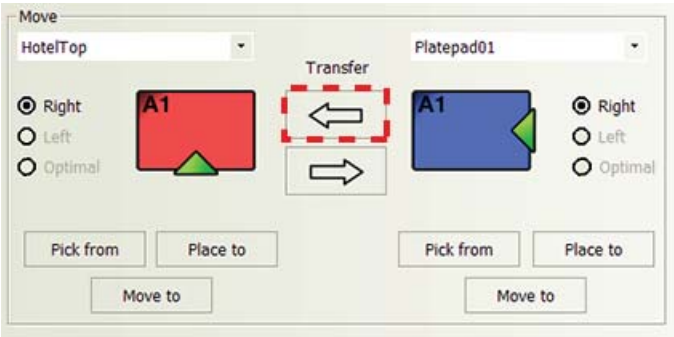
- If the Optimal orientation is selected to indicate that both the right-arm and left-arm orientations are available, select **Right** or **Left**.

  In the following example, the Regrip station allows for both the right- and left-arm orientations (1). To verify the right-arm orientation, Right is selected (2).

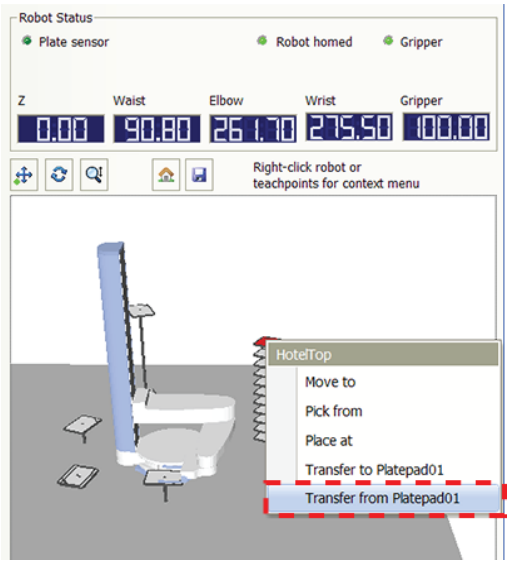


Agilent Technologies recommends that you first verify one set of orientations at a time first. After checking each set of orientations, select **Optimal** to check the optimal path the robot selects.

8 In the **Move** area, click the left-arrow **Transfer** button.



Alternatively, you can right-click the red teachpoint in the **Robot Status** area, and then click **Transfer from <teachpoint_name>**.



The robot picks up the labware at the reference teachpoint, places it at the teachpoint you want to verify, and retreats into the safe zone.

9 Check that the robot seated the labware correctly at the new teachpoint. The robot should not drop the labware, and the labware should be centered at the teachpoint.

Note: If the labware, pick-location, and place-location gripper offset ranges do not overlap, the software will display an error message when you attempt to transfer labware from teachpoint to teachpoint. Correct the error, and then try to transfer the labware again.

10 To make adjustments, proceed to "Editing existing teachpoints" on page 121.

11 Repeat the procedure for another teachpoint. If you are verifying a teachpoint with multiple orientations, be sure to verify each orientation before checking another teachpoint.

12 Repeat the transfer procedure at the **Fast** robot speed (at step 5, select **Fast**).

Related information

For information about...	See...
Planning Direct Drive Robot teachpoints	"Planning Direct Drive Robot teachpoints" on page 79
Using other commands and parameters in the Direct Drive Robot Diagnostics	"Using DDR Diagnostics" on page 137
Quick reference of DDR Diagnostics commands and parameters	"Quick reference" on page 219

Editing existing teachpoints

When you set a teachpoint for the first time, you might set, verify, and edit the teachpoint to make sure the teachpoint is correct. After the teachpoint is set up correctly, you will not need to adjust or redefine it unless you do the following:

- Move the Direct Drive Robot.
- Move or replace one of the devices in the system, such as the robot.
- Adjust settings on the devices.
- Continue to use a robot that has unevenly worn gripper pads.
- Replace the robot gripper pads.

You can edit a teachpoint in one of two ways:

- Adjust the existing teachpoint location by jogging the robot in small increments.
- Replace the existing teachpoint with a new teachpoint.

Adjusting the existing teachpoint

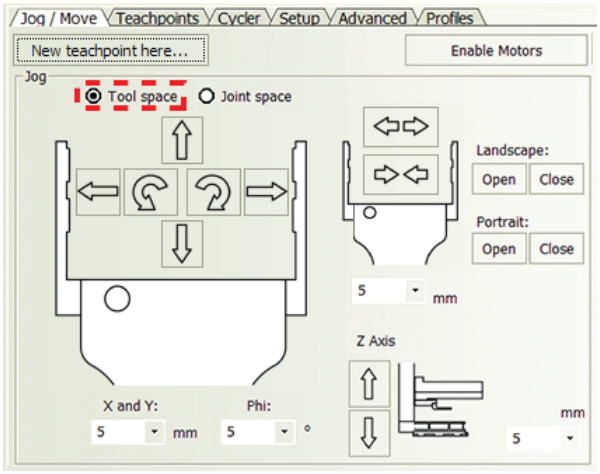
Agilent Technologies recommends that you use the teaching jig when adjusting teachpoints. If you used a labware to set the teachpoints, be sure to use the same labware when adjusting the teachpoints.

WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

WARNING **Stay out of the system while the robot is in motion.**

To adjust a teachpoint:

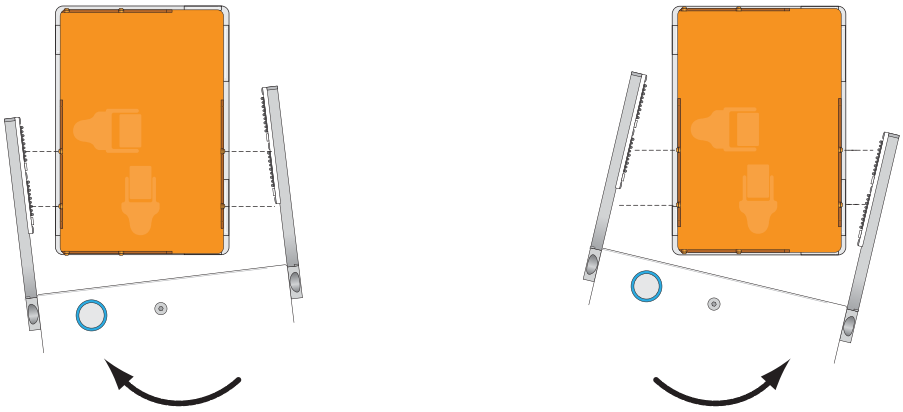
1. Make sure you have followed the procedure in "Verifying teachpoints" on page 109 to determine the adjustments that you need to make to the teachpoint. For example, the robot is currently too far to the left of the teachpoint.
2. Manually place the teaching jig at the teachpoint.
3. In **DDR Diagnostics,** click the **Jog/Move** tab, and then select **Tool space.**



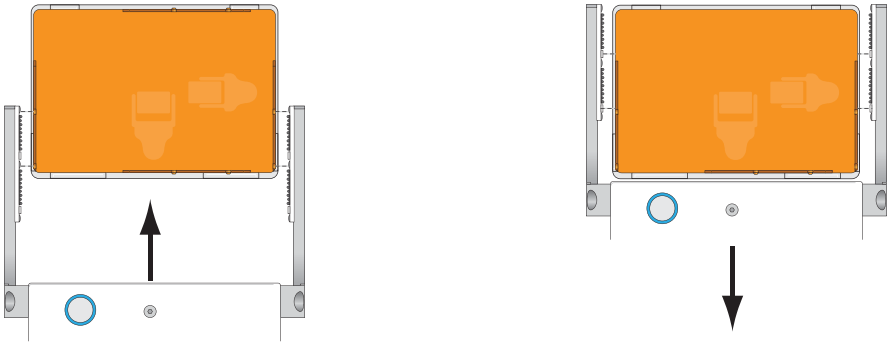
4 In the **Move** area, select the teachpoint you want to adjust, and then click **Move to.** The robot moves to the selected teachpoint. The robot remains at the teachpoint and the grippers are open.

5 Check the position of the robot grippers and the teaching jig. The two pins on both sides of the teaching jig should align with the white dimples in the grippers.

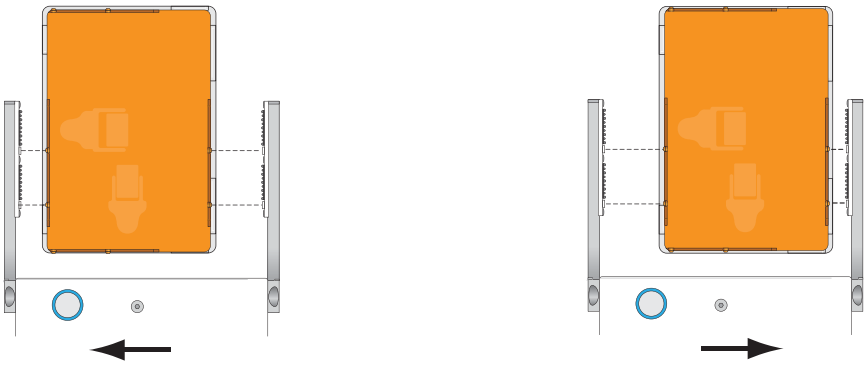
6 If the distances between two adjacent pin-dimple pairs are not the same, make rotational adjustments. In **Tool space,** rotate the robot in small increments along the *Phi*-axis. You can also go into **Joint space** to make rotational adjustments.



7 If the dimples on the robot grippers are farther out or closer than the pins on the teaching jig (as shown in the following diagram), in **Tool space,** jog the robot in small increments along the *y*-axis.

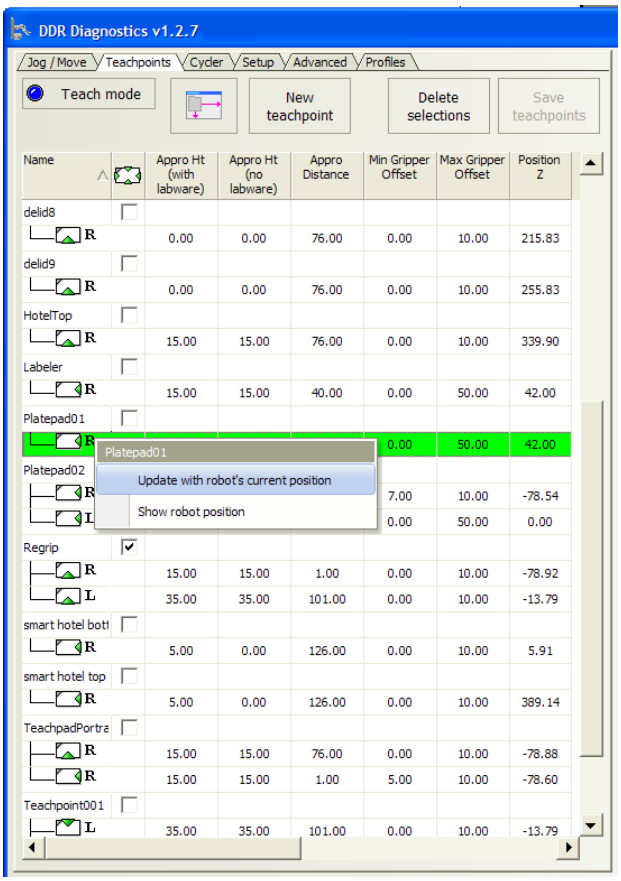


8 If the pin-dimple pairs on one side of the teachpoint are closer or farther than the pairs on the other side (as shown in the following diagram), in **Tool space,** jog the robot in small increments along the x-axis.



9 If the dimples on the grippers are higher or lower than the pins on the teaching jig, decrease or increase the z-axis value.

10 In the **DDR Diagnostics Teachpoints** tab, right-click the orientation icon of the teachpoint you are editing, and select **Update with robot's current position.** The teachpoint coordinates are updated.



Name	Appro Ht (with labware)	Appro Ht (no labware)	Appro Distance	Min Gripper Offset	Max Gripper Offset	Position Z
delid8						
R	0.00	0.00	76.00	0.00	10.00	215.83
delid9						
R	0.00	0.00	76.00	0.00	10.00	255.83
HotelTop						
R	15.00	15.00	76.00	0.00	10.00	339.90
Labeler						
R	15.00	15.00	40.00	0.00	50.00	42.00
Platepad01						
R				0.00	50.00	42.00
Platepad02						
R				7.00	10.00	-78.54
L				0.00	50.00	0.00
Regrip						
R	15.00	15.00	1.00	0.00	10.00	-78.92
L	35.00	35.00	101.00	0.00	10.00	-13.79
smart hotel bott						
R	5.00	0.00	126.00	0.00	10.00	5.91
smart hotel top						
R	5.00	0.00	126.00	0.00	10.00	389.14
TeachpadPortra						
R	15.00	15.00	76.00	0.00	10.00	-78.88
R	15.00	15.00	1.00	5.00	10.00	-78.60
Teachpoint001						
L	35.00	35.00	101.00	0.00	10.00	-13.79

11 Click **Save teachpoints.**

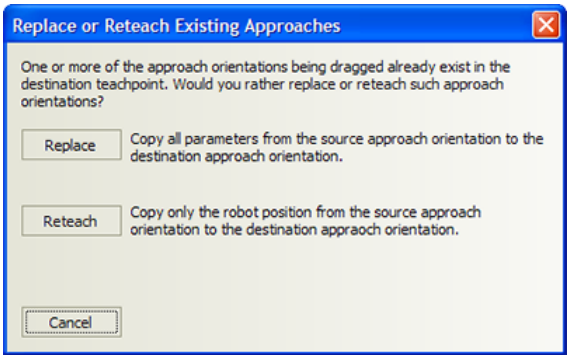
12 Return to "Verifying teachpoints" on page 109 to verify the revised teachpoint.

Replacing the existing teachpoint

CAUTION The replacement procedure also replaces all the teachpoint parameter values such as the approach height and approach distance.

To replace an existing teachpoint:

1. Create a new teachpoint. See "Creating a new teachpoint" on page 93.
2. Set all the parameters for the teachpoint.
3. Drag the new teachpoint and drop it on the existing teachpoint. The Replace or Reteach Existing Approaches dialog opens.


Replace or Reteach Existing Approaches
One or more of the approach orientations being dragged already exist in the destination teachpoint. Would you rather replace or reteach such approach orientations?
Replace
Copy all parameters from the source approach orientation to the destination approach orientation.
Reteach
Copy only the robot position from the source approach orientation to the destination appraoch orientation.
Cancel

4. Click **Replace.** The existing teachpoint and its parameter values are replaced.

Related information

For information about...	See...
DDR Diagnostics	"Software overview" on page 11
Tool space	"Opening and closing the robot grippers" on page 154
Using other commands and parameters in the DDR Diagnostics	"Using DDR Diagnostics" on page 137
Quick reference of DDR Diagnostics commands and parameters	"Quick reference" on page 219

Managing teachpoints

You can rename, copy, or delete existing teachpoints.

Renaming teachpoints

To rename a teachpoint:

1. In the **Teachpoints** tab, select the teachpoint you want to rename.
2. Double-click the teachpoint name, and then type a new name.
3. Click **Save teachpoints** to save the changes in the teachpoint file.

Copying teachpoints

You can use a copy of a teachpoint to create a new teachpoint.

To create a copy of a teachpoint:

1. In the **Teachpoints** tab, click **New Teachpoint.** A new teachpoint entry appears at the bottom of the in the table.
2. Select the teachpoint you want to copy.
3. With the teachpoint selected, Ctrl+drag the teachpoint to the new teachpoint entry.
4. Modify the copy to create a new teachpoint.
5. Click **Save teachpoints** to save the changes in the teachpoint file.

Deleting teachpoints

To delete a teachpoint:

1. In the **Teachpoints** tab, select one or more teachpoints you want to delete in the teachpoints table.
2. Click **Delete selections.**
3. Click **Save teachpoints** to save the changes in the teachpoint file.

Related information

For information about...	See...
Robot Diagnostics	“Software overview” on page 11
Using other commands and parameters in the DDR Diagnostics	“Using DDR Diagnostics” on page 137
Quick reference of DDR Diagnostics commands and parameters	“Quick reference” on page 219

Cycling teachpoints

About teachpoint cycling

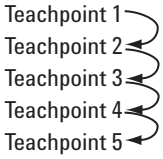
After you have set and verified each teachpoint, you can have the robot transfer labware to and from multiple teachpoints in a cycling pattern as a final check. You can select the teachpoints you want to verify and specify the sequence in which the transfers will occur. Doing so allows you to check the accuracy of the selected teachpoints without having to write or run a protocol.

Cycling sequences

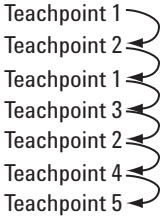
Two types of teachpoint-cycling sequences are available: Sequential, and all permutations.

Sequential

In sequential cycling of teachpoints, the robot will transfer labware to the selected teachpoints in the order you specify. For example, if you select five teachpoints, you can specify the following order:

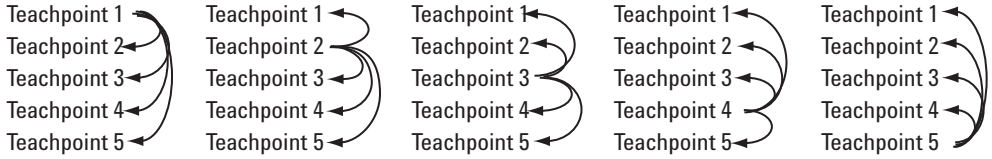


Note: You can select a teachpoint more than once to transfer labware to that location multiple times, as the following example demonstrates.



All permutations

In all-permutations cycling of teachpoints, the robot will transfer robot to the selected teachpoints as shown:



Before you start

Plate stages

IMPORTANT Make sure the device plate stages are extended so that the robot can place labware at these teachpoints during cycling.

The cycling function is a feature of DDR Diagnostics only. During cycling, the VWorks software does not send commands to the devices to open device doors or extend the plate stages. Therefore, you must use the commands in the device diagnostics to move the plate stages into positions before cycling the teachpoints. For instructions on how to move the plate stages into position, see the device user guide.

Labware lids

Be aware that there will be no sensor feedback during cycling. If an error occurs during a delid or relid custom action, the error will not be reported.

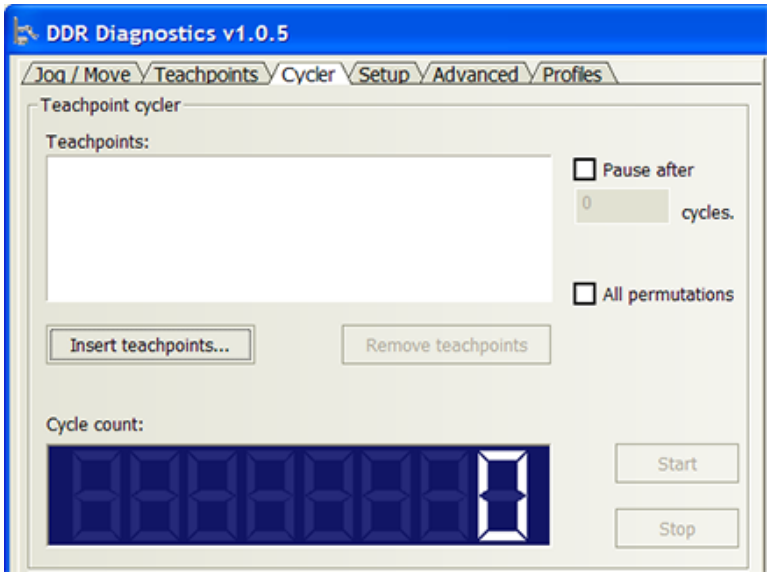
Procedure

WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

WARNING **Stay out of the system while the robot is in motion.**

To transfer labware between multiple teachpoints:

1 In **DDR Diagnostics,** click the **Cycler** tab.

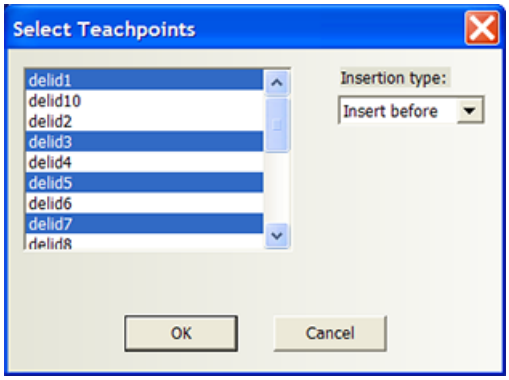


2 Click **Insert teachpoints.** In the **Select Teachpoints** dialog box that opens:

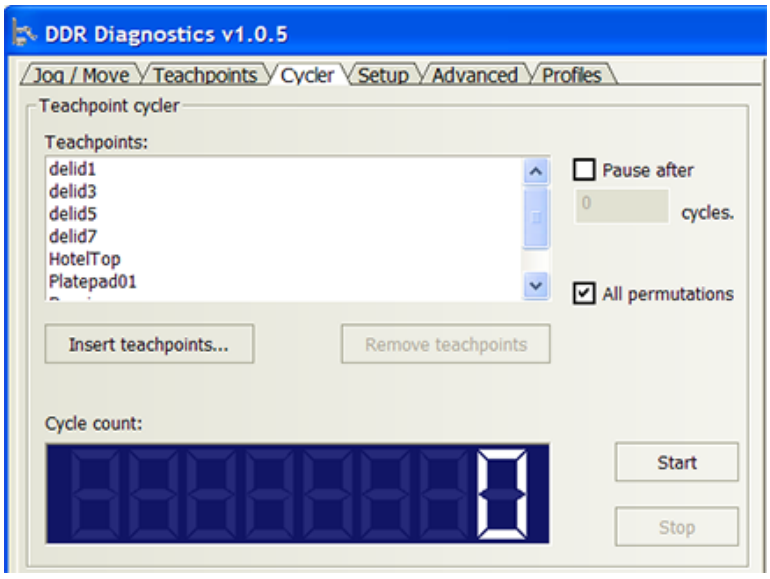
a Select the teachpoints you want to verify. CRTL+click multiple teachpoints to add them simultaneously.

Note: You can select the same teachpoint more than once to indicate that you want to transfer labware to that teachpoint multiple times.

b To arrange the order of the teachpoints, select a teachpoint in the list, and then select either **Insert before** or **Insert after** in the **Insertion types** list.



3 Click **OK** to return to the Cycler tab. The selected teachpoints appear in the Teachpoints list. They should also be in the order you specified.



4 Review the list in the **Teachpoints** area. To remove a teachpoint from the list, select the teachpoint in the list, and then click **Remove teachpoints.**

5 Select **Pause after** if you want to pause the cycling after a specific number of cycles. Type the number of cycles after which you want to pause in the **cycles** box.

6 Select **All permutations** if you want to run that type of cycling sequence. See "Cycling sequences" on page 126.

7 Place the labware at the first teachpoint.

8 When you are ready, click **Start** to begin cycling. Notice that the Start button changes to the Pause button.

During teachpoint cycling, you can:

- Monitor the cycling. To do this, check the number displayed in the **Cycle count** area. You can also view the robot movements in the system or in the **Robot Status** area.
- Pause the cycling. To do this, click **Pause.** The robot will pause after the current pick-and-place action. To resume cycling, click **Resume.**

- Stop the cycling. To do this, click **Stop.** The robot will stop after the current pick-and-place action.

Related information

For information about...	See...
Planning Direct Drive Robot teachpoints	“Planning Direct Drive Robot teachpoints” on page 79
Using other commands and parameters in the Direct Drive Robot Diagnostics	“Using DDR Diagnostics” on page 137
Quick reference of DDR Diagnostics commands and parameters	“Quick reference” on page 219

6
Preparing for a protocol run

Before you start a protocol run, you should check the Direct Drive Robot teachpoints and the protocol to ensure optimum operation.

This chapter contains the following topics:

- "Workflow for preparing a protocol run" on page 132
- "Performing dry runs" on page 134
- "Planning for the protocol run" on page 133
- "Stopping the robot in an emergency" on page 135

Workflow for preparing a protocol run

Workflow

The workflow for preparing a protocol run is as follows:

Step	For this task...	See...
1	Plan for the protocol run.	"Planning for the protocol run" on page 133
2	Perform a dry run.	"Performing dry runs" on page 134
3	Review how to stop the robot and system in an emergency.	• *Direct Drive Robot Site Preparation and Safety Guide* • "Stopping the robot in an emergency" on page 135

Related information

For information about...	See...
Setting up the robot	"Setting up the Direct Drive Robot" on page 49
Setting teachpoints	"Setting teachpoints" on page 77
Troubleshooting the robot	"Troubleshooting robot problems" on page 197

Planning for the protocol run

Reviewing the protocol

Before you start a run, make sure you review the protocol and determine:

- The devices used in the protocol and how to prepare them for operation. For example, you might need to load a roll of seal on the PlateLoc Sealer or install a pipette head on a Vertical Pipettor. See the device user guides for setup instructions.
- The optimal device setup sequence. In general, you first set up devices that do not hold time-sensitive reagents. Leave complex preparations, which might use expensive and unstable reagents, until last.
- The labware used in the protocol and where they should be positioned before the run starts. For example, you might have to load labware into one or more storage devices such as the Labware Stacker and the Plate Hub Carousel.
- Remove any obstacle in the robot's pathways.
- The waste bins that should be emptied.
- The reservoirs that must be filled.

Be sure to check the protocol User Message tasks for setup information. If the User Message tasks prompt you to place counterweight labware, you do not have to include these steps in the setup.

Reviewing the teachpoint file

Before loading labware in storage devices, always review the teachpoint file for labware orientation information. The labware must be loaded in the same orientation as specified in the teachpoint file.

Related information

For information about...	See...
Creating or revising protocols	*VWorks Automation Control User Guide*
Performing dry runs	"Performing dry runs" on page 134
Stopping the robot in an emergency	"Stopping the robot in an emergency" on page 135

Performing dry runs

What is a dry run?

A dry run is when you run a protocol using empty labware. A dry run allows you to troubleshoot a protocol or a component of the system without wasting valuable reagents and samples. You should always perform a dry run to check a new protocol.

Correcting teachpoint errors

After setting the teachpoints, be sure to perform a dry run as a final check for any teachpoint errors. The dry run also allows you to fine-tune orientation settings in systems that have the Direct Drive Robot.

Preparing for a dry run

You prepare for a dry run the same way you would prepare for a real protocol run. To review the protocol before a dry run, see "Planning for the protocol run" on page 133.

Related information

For information about...	See...
Writing protocols	*VWorks Automation Control User Guide*
Preparing for a run	"Workflow for preparing a protocol run" on page 132
Setting teachpoints	"Setting teachpoints" on page 77
Troubleshooting the robot	"Troubleshooting robot problems" on page 197

Stopping the robot in an emergency

About this topic

This topic explains how to stop the robot in an emergency using the supplied emergency stop pendant. See also the *Direct Drive Robot Site Preparation and Safety Guide* for other safety information.

WARNING **If the robot is integrated with other devices in a system, Agilent Technologies recommends that you install a main emergency stop button to cut power to the robot and all devices simultaneously. In addition, all operators must be instructed the emergency stop procedure.**

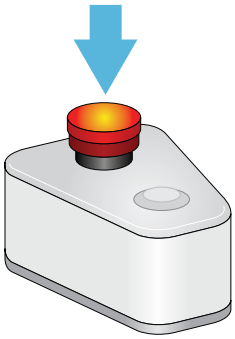
Note: To pause and continue a run, use the Pause command in the VWorks software. You can also stop a run using the Stop command in the software. For instructions, see the *VWorks Automation Control User Guide*.

Using the emergency stop pendant

To stop the robot in an emergency:

Press the red button on the emergency stop pendant. Power is cut from the robot and it stops.

Figure Emergency stop pendant.



To restore the robot for normal operation, see "Recovering from an emergency stop" on page 198.

Related information

For information about...	See...
Recovering from an emergency stop	"Recovering from an emergency stop" on page 198
Shutdown procedure	"Turning on and turning off the robot" on page 46
General safety information	*Direct Drive Robot Site Preparation and Safety Guide*

7 Using DDR Diagnostics

This chapter explains how to use the provided software tools to diagnose and troubleshoot the Direct Drive Robot.

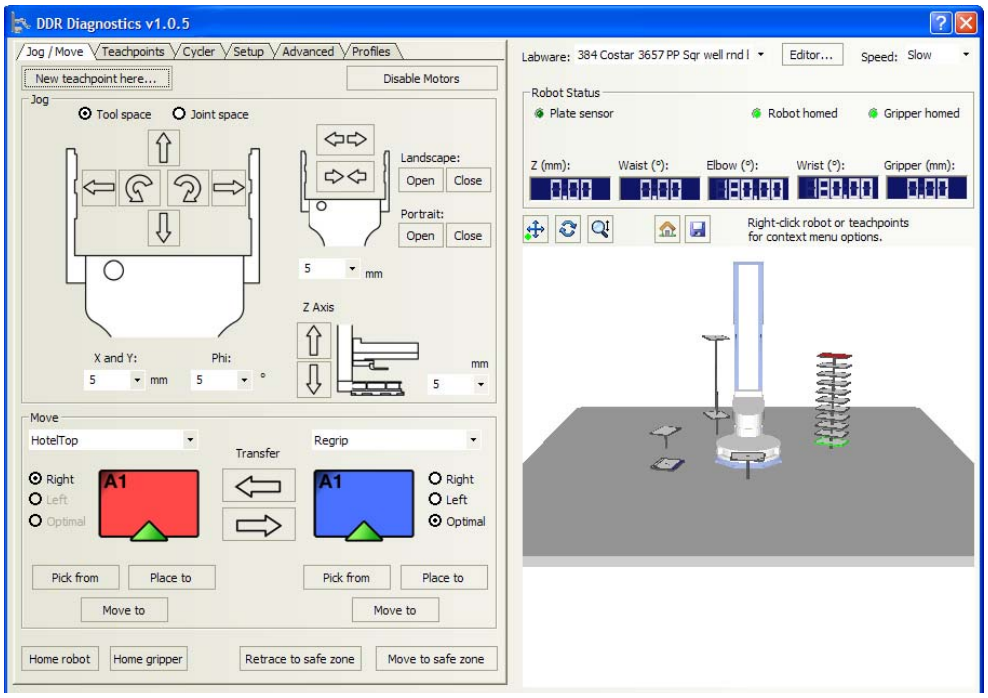
This chapter contains the following topics:

- "About DDR Diagnostics" on page 138
- "Homing the robot and grippers" on page 140
- "Moving the robot into the safe zone" on page 142
- "Jogging the robot" on page 145
- "Disabling and enabling the robot motors" on page 148
- "Stopping the robot motors" on page 149
- "Changing the robot speed" on page 150
- "Changing the robot speed definitions" on page 151
- "Opening and closing the robot grippers" on page 154
- "Changing the gripper settings" on page 156
- "Checking the robot microplate sensor" on page 159
- "Changing the robot display" on page 161
- "Checking the temperature and bus voltage" on page 163
- "Restoring robot settings" on page 166
- "Updating the firmware" on page 168
- "Backing up the robot firmware" on page 170
- "Restoring existing firmware" on page 172
- "Viewing the DDR Diagnostics log area" on page 174
- "Saving the controller log to file" on page 175

About DDR Diagnostics

WARNING **Only administrators and trained personnel should perform the procedures in this chapter.**

The DDR Diagnostics software allows you to control the motions of the Direct Drive Robot. The software has six tabs: Jog/Move, Teachpoints, Cycler, Setup, Advanced, and Profiles. You use the commands and parameters available in the these tabs to troubleshoot problems.



Related information

For information about...	See...
Complete list of available commands you can use in DDR Diagnostics	"Quick reference" on page 219

For information about...	See...
Jog/Move tab	• "Disabling and enabling the robot motors" on page 148 • "Jogging the robot" on page 145 • "Opening and closing the robot grippers" on page 154 • "Homing the robot and grippers" on page 140 • "Verifying teachpoints" on page 109 • "Moving the robot into the safe zone" on page 142 • "Moving the robot into the safe zone" on page 142
Teachpoints tab	• "Setting teachpoints" on page 88 • "Editing existing teachpoints" on page 121
Cycler tab	"Cycling teachpoints" on page 126
Setup tab	• "Changing the robot speed definitions" on page 151 • "Changing the gripper settings" on page 156 • "Specifying the table dimensions and robot position" on page 69 • "Restoring robot settings" on page 166
Advanced tab	• "Updating the firmware" on page 168 • "Saving the controller log to file" on page 175 • "Checking the temperature and bus voltage" on page 163
Profiles tab	"Creating Direct Drive Robot profiles" on page 56

Homing the robot and grippers

Homing the robot

Homing the robot sends the robot to the factory-defined home position for each of the axes of motion. To home the grippers, see "Homing the robot grippers" on page 141.

Home the robot if you notice that the robot is not accurately picking up or placing labware. You might also want to home the robot after recovering from an emergency stop.

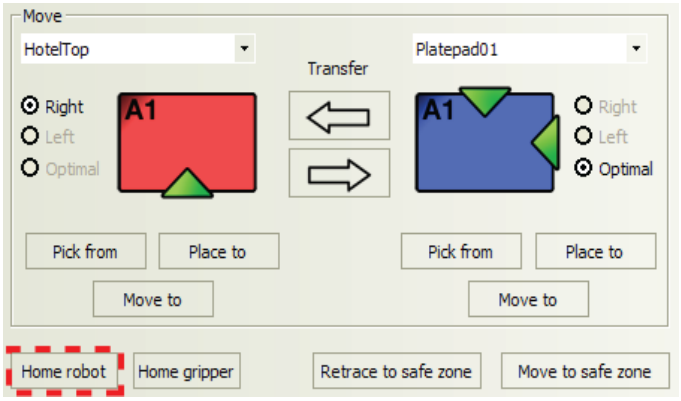
Note: The robot homes automatically only when you initialize the robot. If the robot is already homed, the robot will skip the homing process during initialization.

WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

WARNING **Stay out of the system while the robot is in motion.**

To home the robot:

In the **Jog/Move** tab, click **Home robot.** The robot moves its joints until it finds the home position.

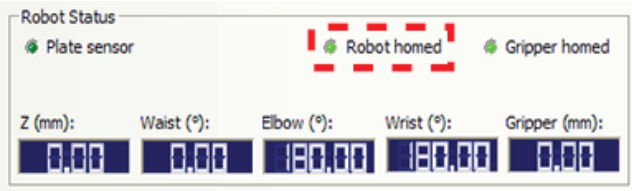


The homing process can take up to 2 minutes. During this time, the robot:

1. Checks for the presence of labware in its grippers. If labware is present, the software presents an error message. You must first remove the labware before homing.
2. Homes the grippers.
3. Looks for the home position for each joint (waist, elbow, and wrist) and moves to the home positions.
4. Looks for the home position along the *z*-axis and moves to the home position.

Note: If the robot hand is at the same height as the robot base, the robot will first raise the arm to clear the base before starting the homing sequence.

After the robot is homed, the Robot homed indicator light turns on.



Homing the robot grippers

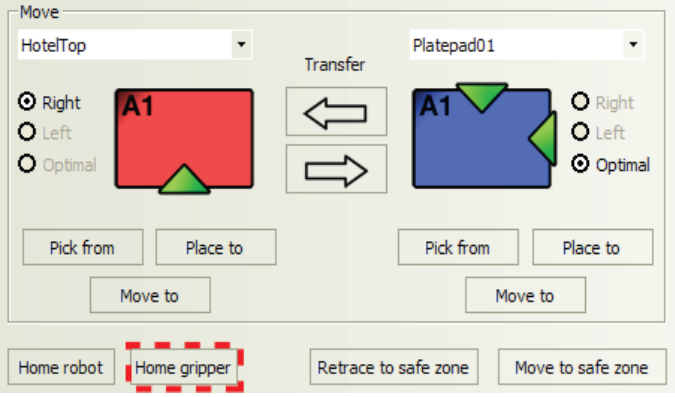
Homing the grippers does not home the rest of the robot.

WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

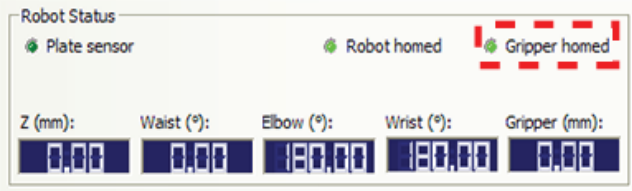
WARNING **Stay out of the system while the robot is in motion.**

To home the robot grippers:

In the **Jog/Move** tab, click **Home grippers.** The robot opens and closes its gripers until it finds the home position.



After the grippers are homed, the Gripper indicator light turns on.



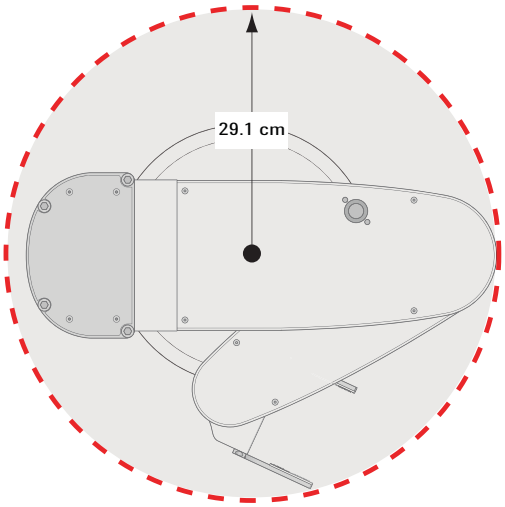
Related information

For information about...	See...
Moving the robot into the safe zone	"Moving the robot into the safe zone" on page 142

For information about...	See...
Disabling and enabling the robot motor	"Disabling and enabling the robot motors" on page 148
Stopping the robot motors	"Stopping the robot motors" on page 149
Changing the robot speed	"Changing the robot speed" on page 150
Jogging the robot	"Jogging the robot" on page 145
Opening and closing the robot grippers	"Opening and closing the robot grippers" on page 154
Checking the robot microplate sensor	"Checking the robot microplate sensor" on page 159
Changing the robot display	"Changing the robot display" on page 161
Viewing the log area	"Viewing the DDR Diagnostics log area" on page 174

Moving the robot into the safe zone

The safe zone is the region within which the robot is allowed to move without colliding with external devices. For the Direct Drive Robot, it is the cylindrical region within the red-dotted line as shown in the following diagram. The radius of the cylinder, measured from the center of the base, is 29.1 cm (11.4 in).



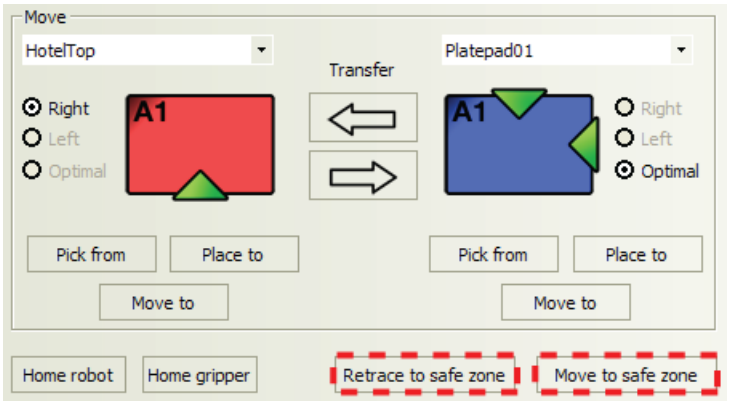
In general, the Direct Drive Robot moves into the safe zone after it completes a Move to, Pick from, Place to, or Transfer command. However, you can move the robot into the safe zone at other times to move it out of the way.

CAUTION Make sure you save new teachpoints in the teachpoint file before moving the robot. The robot can crash into devices at unknown (unsaved) teachpoints.

WARNING **Stay out of the system while the robot is in motion.**

To move the robot into the safe zone:

Click one of the following:



Command	Description
Move to safe zone	The robot searches for the closest teachpoint, and then uses the safest path from that teachpoint to the safe zone. If the robot is unable to find a teachpoint nearby, it retracts radially into the safe zone. Use the Move to safe zone command if it is close to a teachpoint and the path from that teachpoint to the safe zone is clear of obstacles.
Retrace to safe zone	The robot searches for the closest teachpoint, and then uses the path from that teachpoint to the safe zone. If the robot is unable to find a teachpoint nearby, it will retreat into the safe zone by retracing the path it took to reach the current location. Use the Retrace to safe zone command when, for example, the robot grippers are within a device, and using the Move to safe zone command might cause the robot to run into the sides of the device or other obstacles.

Related information

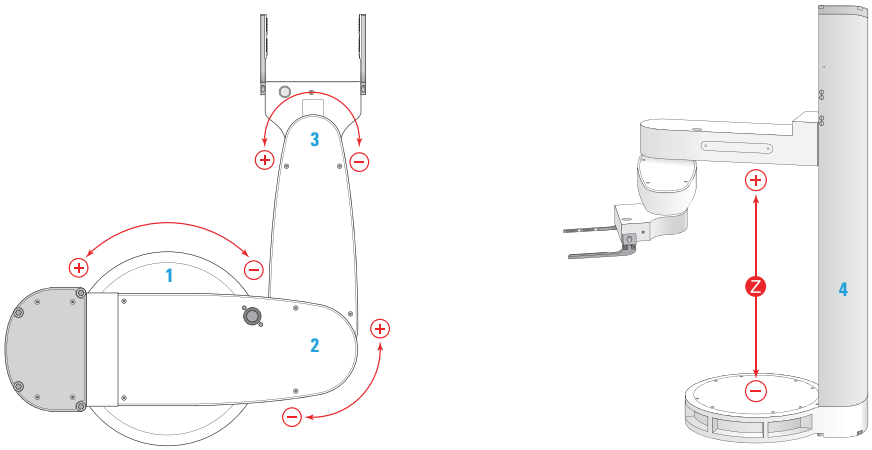
For information about...	See...
Homing the robot	“Homing the robot and grippers” on page 140
Disabling and enabling the robot motor	“Disabling and enabling the robot motors” on page 148
Stopping the robot motors	“Stopping the robot motors” on page 149
Changing the robot speed	“Changing the robot speed” on page 150
Jogging the robot	“Jogging the robot” on page 145
Opening and closing the robot grippers	“Opening and closing the robot grippers” on page 154
Checking the robot microplate sensor	“Checking the robot microplate sensor” on page 159
Changing the robot display	“Changing the robot display” on page 161
Viewing the log area	“Viewing the DDR Diagnostics log area” on page 174

Jogging the robot

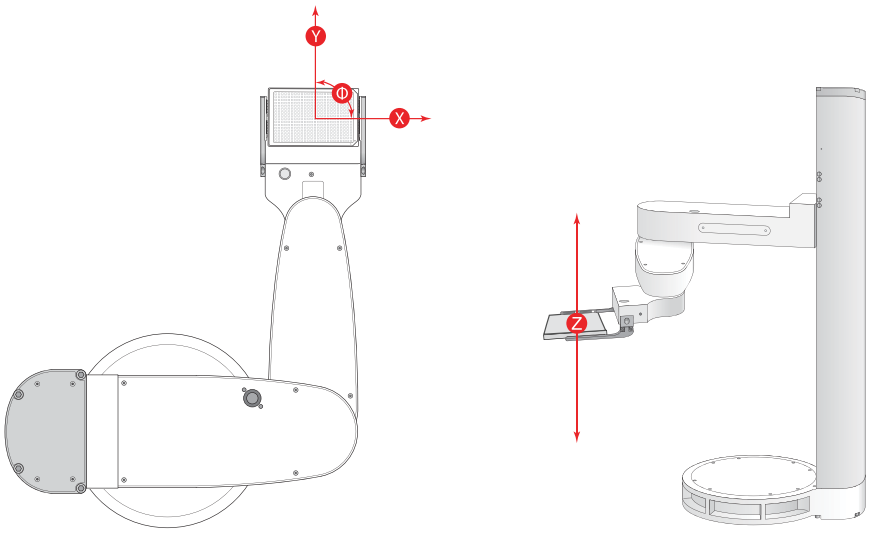
Jogging the robot moves the robot in small, precise increments. You can jog the robot to fine-tune its position when creating and editing teachpoints or during troubleshooting.

The Direct Drive Robot movements can be controlled or monitored from two different perspectives:

- *Joint space*. You can use a joint-space command to rotate the robot about its waist (1), rotate its forearm about the elbow (2), or rotate the hand about the wrist (3). In addition, you can move the robot arm up and down along the mast or *z*-axis (4).



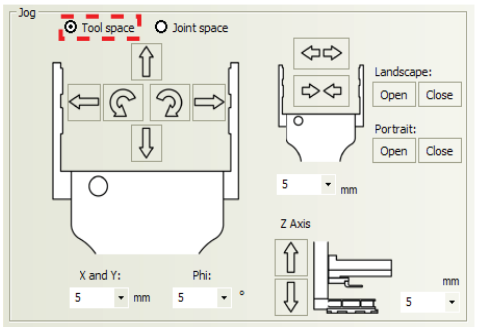
- *Tool space*. You can use a tool-space command to move a combination of robot joints so that the labware moves to its target location along the *x*- or *y*-axis. In addition, you can rotate the labware (*Phi* angle) and move the robot arm up and down along the mast or *z*-axis. In tool space, all movements are measured with respect to the center of the labware.



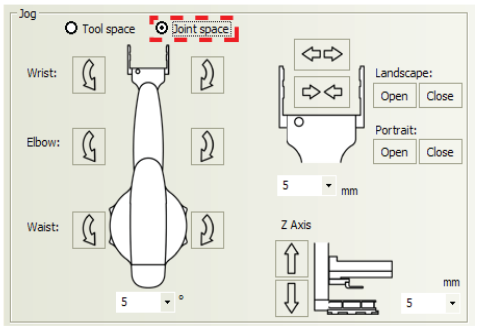
To select a perspective:

In the **Jog/Move** tab, select **Tool space** (1) or **Joint space** (2).

1



2

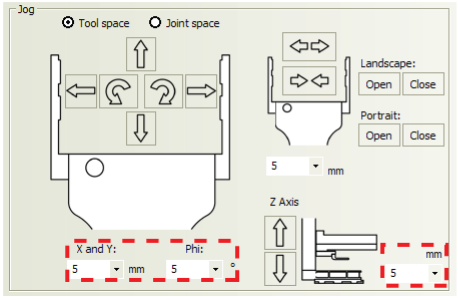


To jog the robot:

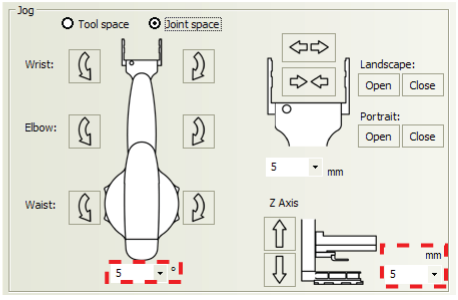
1 Select or type the jog increment for the axis or joint you want to move. The jog increments are in millimeters or degrees.

CAUTION Always select small jog increments so that the robot does not bump into obstacles in its path.

1



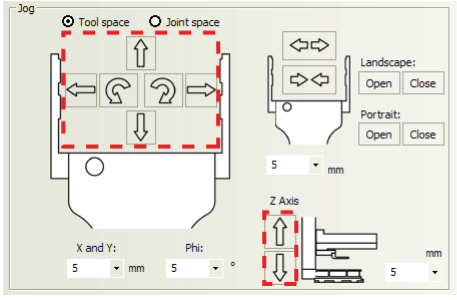
2



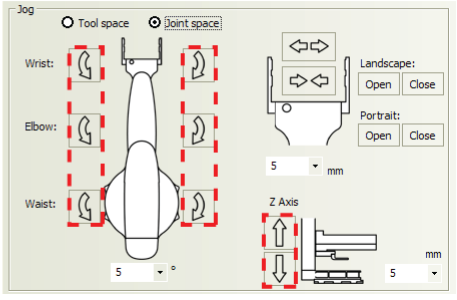
2 Click one of the jog direction buttons.

WARNING **Stay out of the system while the robot is in motion.**

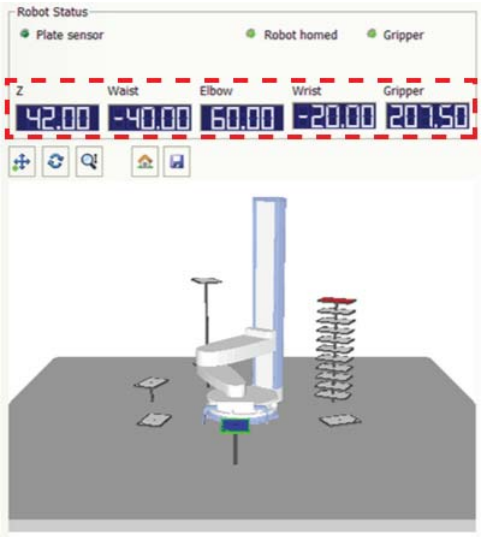
1



2



In the **Robot Status** area, the current joint and *z*-axis coordinates are updated.



Related information

For information about...	See...
Setting teachpoints	"Setting teachpoints" on page 77
Disabling and enabling the robot motors	"Disabling and enabling the robot motors" on page 148
Moving labware between teachpoints	• "Moving the robot to the new teachpoint" on page 109 • "Picking up labware at the teachpoint" on page 112 • "Placing labware at the teachpoint" on page 115 • "Transferring labware between two teachpoints" on page 117
Homing the robot	"Homing the robot and grippers" on page 140
Moving the robot into the safe zone	"Moving the robot into the safe zone" on page 142
Changing the robot speed	"Changing the robot speed" on page 150
Stopping the robot motors	"Stopping the robot motors" on page 149
Changing the robot display	"Changing the robot display" on page 161
Viewing the log area	"Viewing the DDR Diagnostics log area" on page 174

Disabling and enabling the robot motors

Disabling the robot motors allows you to move the robot by hand. When you disable the robot motors, the robot will first finish the current command before stopping.

IMPORTANT You can disable the robot joint motors, but you cannot disable the *z*-axis motor. Therefore, you can move the robot by hand in the plane of the robot arm, but you cannot change its height.

Note: If the system is not running a protocol, and the robot remains inactive for 10 minutes, the motors are automatically disabled.

WARNING **The robot arm might move when the motors are being enabled. Stay out of the system when you enable the robot.**

To disable or enable the robot motors:

In the **DDR Diagnostics** **Jog/Move** tab, click **Disable Motors** or **Enable Motors.**

Related information

For information about...	See...
Homing the robot	"Homing the robot and grippers" on page 140
Moving the robot into the safe zone	"Moving the robot into the safe zone" on page 142
Stopping the robot motors	"Stopping the robot motors" on page 149
Changing the robot speed	"Changing the robot speed" on page 150
Jogging the robot	"Jogging the robot" on page 145
Opening and closing the robot grippers	"Opening and closing the robot grippers" on page 154
Checking the robot microplate sensor	"Checking the robot microplate sensor" on page 159
Changing the robot display	"Changing the robot display" on page 161
Viewing the log area	"Viewing the DDR Diagnostics log area" on page 174

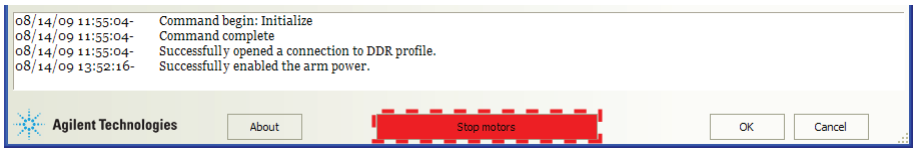
Stopping the robot motors

In an emergency, you can use the Stop Motors command to cut power to the robot motors, thus stopping the robot immediately.

To stop the robot motors:

In **DDR Diagnostics**, click **Stop Motors** at the bottom of the dialog box. The robot stops immediately.

Alternatively, if the pointer or cursor is not currently in any text box in the dialog box, you can press the space bar on the keyboard to stop the robot motors.



Related information

For information about...	See...
Stopping the robot in an emergency using the emergency stop pendant	"Stopping the robot in an emergency" on page 135
Homing the robot	"Homing the robot and grippers" on page 140
Moving the robot into the safe zone	"Moving the robot into the safe zone" on page 142
Disabling and enabling the robot motors	"Disabling and enabling the robot motors" on page 148
Changing the robot speed	"Changing the robot speed" on page 150
Jogging the robot	"Jogging the robot" on page 145
Opening and closing the robot grippers	"Opening and closing the robot grippers" on page 154
Checking the robot microplate sensor	"Checking the robot microplate sensor" on page 159
Changing the robot display	"Changing the robot display" on page 161
Viewing the log area	"Viewing the DDR Diagnostics log area" on page 174

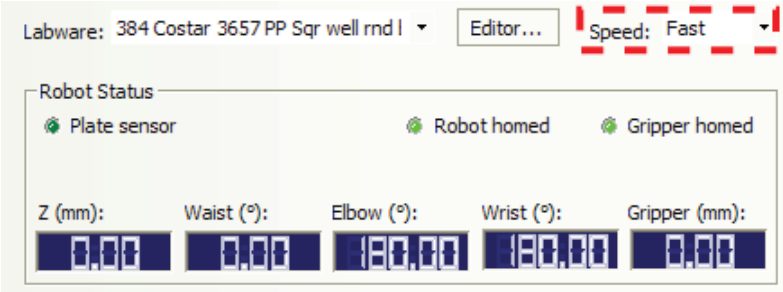
Changing the robot speed

You can select the robot speed to accommodate the task you are performing. For example, you can select the Slow speed when you are creating new teachpoints or diagnosing problems with the system. When you are confident that problems are resolved and want to run a final check, you can select the Fast speed.

The speed you select in DDR Diagnostics applies only to the robot commands in DDR Diagnostics (jog direction, Move to, Pick from, Place to, and Transfer).

To select the robot speed:

In **DDR Diagnostics**, select one of the following from the **Speed** list: **Fast, Medium,** or **Slow.**



Note: During a protocol run, the robot will use the speed selection in the VWorks software Tools > Options dialog box. If the robot is holding a microplate, the slower of the following will be applied: the speed in the Labware Editor or the speed in the Tools > Options dialog box. For more information, see the *VWorks Automation Control Setup Guide* and *VWorks Automation Control User Guide*.

Related information

For information about...	See...
Homing the robot	"Homing the robot and grippers" on page 140
Moving the robot into the safe zone	"Moving the robot into the safe zone" on page 142
Disabling and enabling the robot motors	"Disabling and enabling the robot motors" on page 148
Stopping the robot motors	"Stopping the robot motors" on page 149
Jogging the robot	"Jogging the robot" on page 145
Opening and closing the robot grippers	"Opening and closing the robot grippers" on page 154
Checking the robot microplate sensor	"Checking the robot microplate sensor" on page 159

For information about...	See...
Changing the robot display	"Changing the robot display" on page 161
Viewing the log area	"Viewing the DDR Diagnostics log area" on page 174

Changing the robot speed definitions

About robot speeds

Three robot speeds (Fast, Medium, Slow) are available for selection in DDR Diagnostics, VWorks Options (under the Tools menu), and Labware Editor. You select a robot speed to accommodate the task you are performing. For example, you can select the Slow speed when you are creating new teachpoints, creating and testing protocols, or diagnosing problems with the system.

Each speed is defined as a percentage of the factory-set maximum speed. By default, the percentages are defined as follows:

Speed	Default
Slow	20%
Medium	50%
Fast	80%

You can change these speed definitions to accommodate your laboratory's needs.

IMPORTANT The speed definitions are universal and apply to the speeds you select in DDR Diagnostics, Labware Editor, and the VWorks Options dialog box.

Note: The speed you select in DDR Diagnostics applies only to the robot commands in DDR Diagnostics (Jog, Move, Transfer, and so on). If the robot is holding a labware, the slower of the following will be applied: the speed you selected in the Labware Editor, or the speed you selected in DDR Diagnostics.

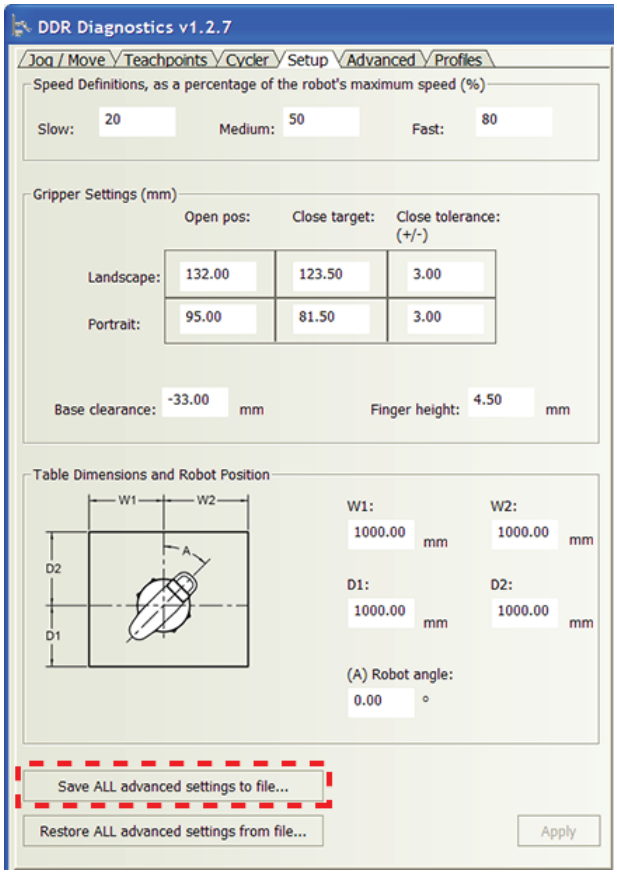
Similarly the speed selection in VWorks Options (under the Tools menu) applies to protocol runs. If the robot is holding a labware, the slower of the following will be applied: the speed you selected in the Labware Editor, or the speed you selected in VWorks Options.

Backing up existing settings

Agilent Technologies recommends that you back up the existing speed definitions before changing them.

To back up existing settings:

1 In the **DDR Diagnostics Setup** tab, click **Save ALL advanced settings to file.**



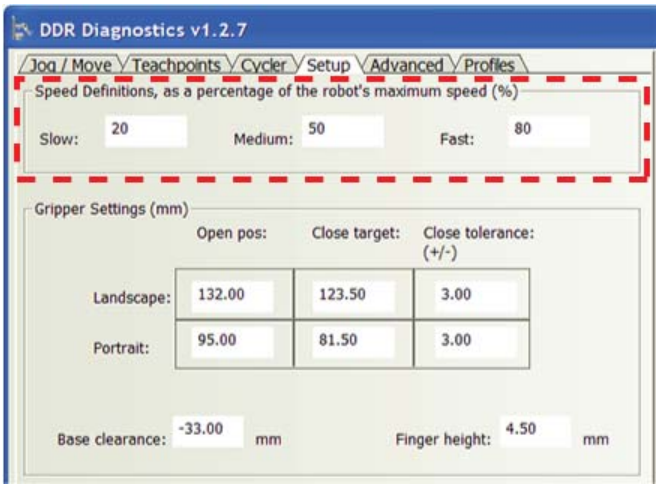
2 In the Save As dialog box that opens, type a name for the backup file. You can use the default backup file location, or select a different location. The default location is C:\Program Files\Agilent Technologies\Settings\DDR\FirmwareBackup.

3 Click **Save.** The robot settings are saved in an XML file.

Specifying new speed definitions

To change the speed definitions:

1 In DDR Diagnostics, click the **Setup** tab.



2 In the **Speed Definitions** area, type the new percentage for one or more of the speeds you want to re-define.

3 When you are finished, click **Apply.** The changes are saved to the firmware.

Related information

For information about...	See...
Selecting a robot speed in DDR Diagnostics	"Changing the robot speed" on page 150
Selecting a robot speed in the Labware Editor	*VWorks Automation Control Setup Guide*
Selecting a robot speed in Protocol Options	*VWorks Automation Control User Guide*
Changing the gripper settings	"Changing the gripper settings" on page 156
Specifying table dimensions and robot position	"Specifying the table dimensions and robot position" on page 69
Restoring robot settings	"Restoring robot settings" on page 166

Opening and closing the robot grippers

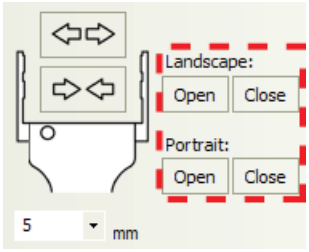
You can open the robot grippers to release labware. You can close the robot grippers to hold labware.

WARNING **Be sure to wear protective eyewear when entering the system and working with the robot.**

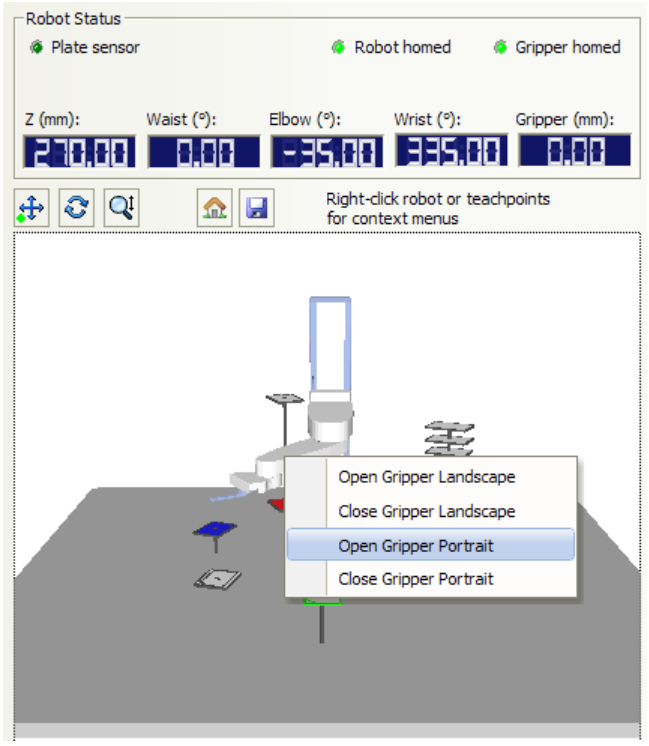
WARNING **Stay out of the system while the robot is in motion.**

To open or close the robot grippers:

In the **Jog/Teach** tab, click **Open** or **Close** for the desired orientation.



Alternatively, you can right-click the robot arm or mast in the Robot Status area, and then click the open or close gripper command for the desired orientation.

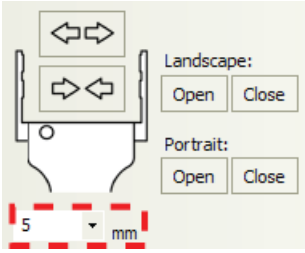


To open or close the grippers incrementally:

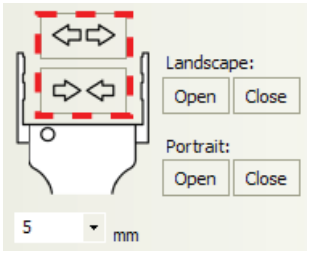
1 In the **Jog/Teach** tab, select or type the jog increment for the grippers.

CAUTION Always select smaller jog increments so that the robot does not bump into labware when it opens its grip, or bend the labware when it closes its grip.

IMPORTANT The jog increment applies to both grip directions.



2 Click either the open or close gripper buttons.



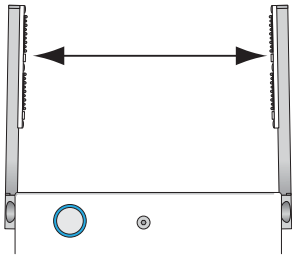
Related information

For information about...	See...
Homing the robot	“Homing the robot and grippers” on page 140
Moving the robot into the safe zone	“Moving the robot into the safe zone” on page 142
Disabling and enabling the robot motors	“Disabling and enabling the robot motors” on page 148
Changing the robot speed	“Changing the robot speed” on page 150
Stopping the robot motors	“Stopping the robot motors” on page 149
Jogging the robot	“Jogging the robot” on page 145
Checking the robot microplate sensor	“Checking the robot microplate sensor” on page 159
Changing the robot display	“Changing the robot display” on page 161
Viewing the log area	“Viewing the DDR Diagnostics log area” on page 174

Changing the gripper settings

About the gripper settings

The following gripper settings are set at the factory:

Gripper setting	Description
Open pos	The distance, in millimeters, between the grippers when they are open. The default values are: • 132 mm (landscape) • 95 mm (portrait) 
Close target	The approximate distance, in millimeters, between the grippers when they are closed. The default values are: • 123.5 mm (landscape) • 81.5 mm (portrait) The Close target value is always used with the Close tolerance value. When picking up labware, the grippers close until the Grip torque (set in the Labware Editor) is reached. Then, the robot checks to see if the distance between the grippers is within the Close target value +/- the Close tolerance value. If it is outside the summed value, the software will display an error message.
Close tolerance	The distance, in millimeters, the Close target is allowed to vary without causing an error. The default value is +/-3 mm.

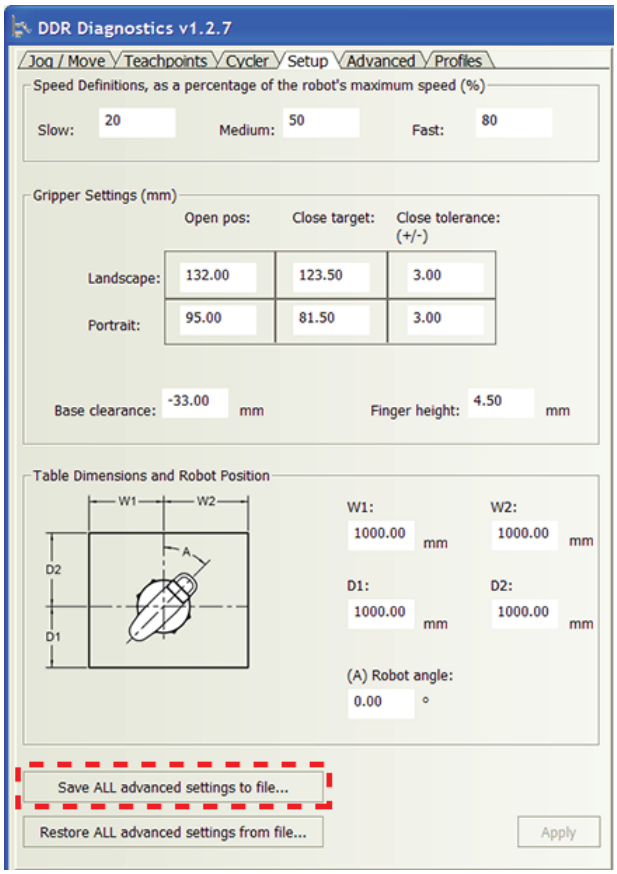
The default gripper settings should work for labware that meet the American National Standards Institute (ANSI) standards. However, you can fine-tune the settings to accommodate different labware materials, such as soft PCR microplates.

Backing up existing settings

Agilent Technologies recommends that you back up the existing gripper settings before changing them.

To back up existing settings:

1 In the **DDR Diagnostics Setup** tab, click **Save ALL advanced settings to file.**



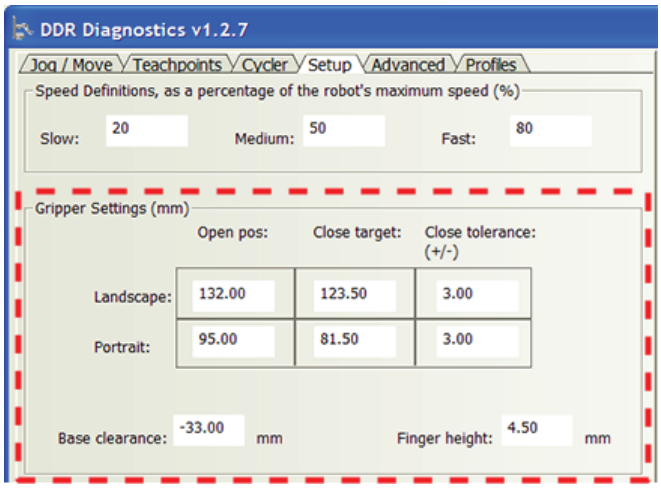
2 In the Save As dialog box that appears, type a name for the backup file. You can use the default backup file location, or select a different location. The default location is C:\Program Files\Agilent Technologies\Settings\DDR\FirmwareBackup.

3 Click **Save.** The robot settings are saved in an XML file.

Specifying new settings

To change the gripper settings:

1 In DDR Diagnostics, click the **Setup** tab.



2 In the **Gripper Settings** area, type the new values you want to use for **Open pos**, **Close target**, and **Close tolerance.**

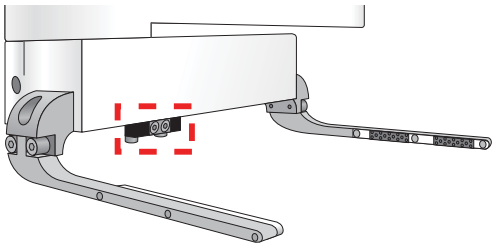
3 When you are finished, click **Apply.** The changes are saved to the firmware.

Related information

For information about...	See...
Opening and closing the grippers using software controls	"Opening and closing the robot grippers" on page 154
Manually opening and closing the grippers	"Gripper lead screw locations" on page 6

Checking the robot microplate sensor

The microplate sensor under the robot hand is used to detect the presence of labware in its grip. If you suspect that the microplate sensor is not working correctly, you can check to see if it requires recalibration.



To check the microplate sensor:

1. Move the robot to a teachpoint that has a labware.
2. Move the robot up so that it is at the correct robot gripper offset for the labware.
3. Close the gripper.
4. Move the robot away from the teachpoint. The microplate sensor is highly sensitive and might detect the plate stage or platepad as labware. Moving the robot away from any teachpoint would provide the most accurate detection result.
5. In the **Robot Status** area, check the **Plate sensor** indicator.

   If the indicator light is on, the microplate sensor is detecting a labware in its grippers.

   If the indicator light is off, the microplate sensor is not detecting labware. Contact Automation Solutions Technical Support to see if the sensor needs to be recalibrated.

6. Open the gripper to release the labware.

Related information

For information about...	See...
Homing the robot	"Homing the robot and grippers" on page 140
Moving the robot into the safe zone	"Moving the robot into the safe zone" on page 142

For information about...	See...
Disabling and enabling the robot motors	"Disabling and enabling the robot motors" on page 148
Changing the robot speed	"Changing the robot speed" on page 150
Stopping the robot motors	"Stopping the robot motors" on page 149
Jogging the robot	"Jogging the robot" on page 145
Opening and closing the robot grippers	"Opening and closing the robot grippers" on page 154
Changing the robot display	"Changing the robot display" on page 161
Viewing the log area	"Viewing the DDR Diagnostics log area" on page 174

Changing the robot display

In the Robot Status area, a graphical representation of the Direct Drive Robot shows the robot posture, teachpoints, and the system table. You can change the view using the buttons above the image.

Button	Description
	Pans, or moves the image. Click the button, and then drag the image in the desired direction.
	Rotates the image. Click the button, and then drag the image to rotate it in the desired direction. Alternatively, click the middle mouse button or wheel, and then drag the image to rotate it.
	Increases or reduces the image magnification. Click the button, and then drag the image upward or downward to increase or decrease the magnification respectively. Alternatively, scroll the mouse wheel to change the magnification.
	Resets the image to the default view.
	Saves the current view as the default view.

Related information

For information about...	See...
Homing the robot	“Homing the robot and grippers” on page 140
Moving the robot into the safe zone	“Moving the robot into the safe zone” on page 142
Disabling and enabling the robot motors	“Disabling and enabling the robot motors” on page 148
Changing the robot speed	“Changing the robot speed” on page 150
Stopping the robot motors	“Stopping the robot motors” on page 149
Jogging the robot	“Jogging the robot” on page 145
Opening and closing the robot grippers	“Opening and closing the robot grippers” on page 154
Checking the robot microplate sensor	“Checking the robot microplate sensor” on page 159

For information about...	See...
Viewing the log area	"Viewing the DDR Diagnostics log area" on page 174

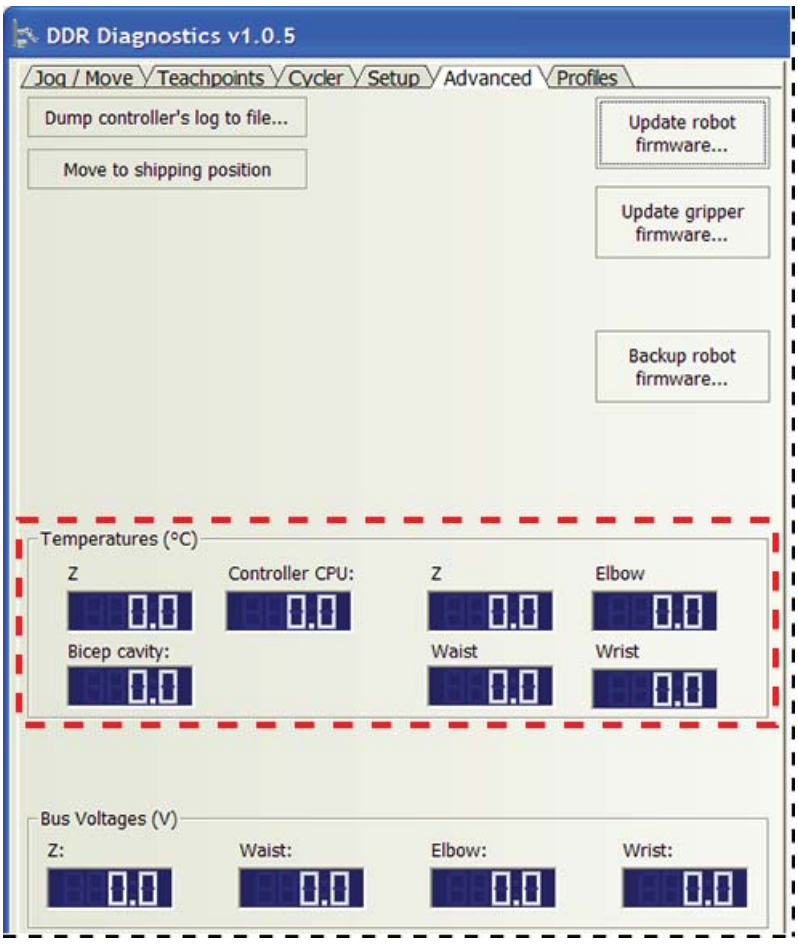
Checking the temperature and bus voltage

About this topic

The robot temperature and bus voltage can be useful for troubleshooting problems. This topic explains where you can find the temperature and bus voltage information.

Checking the temperature

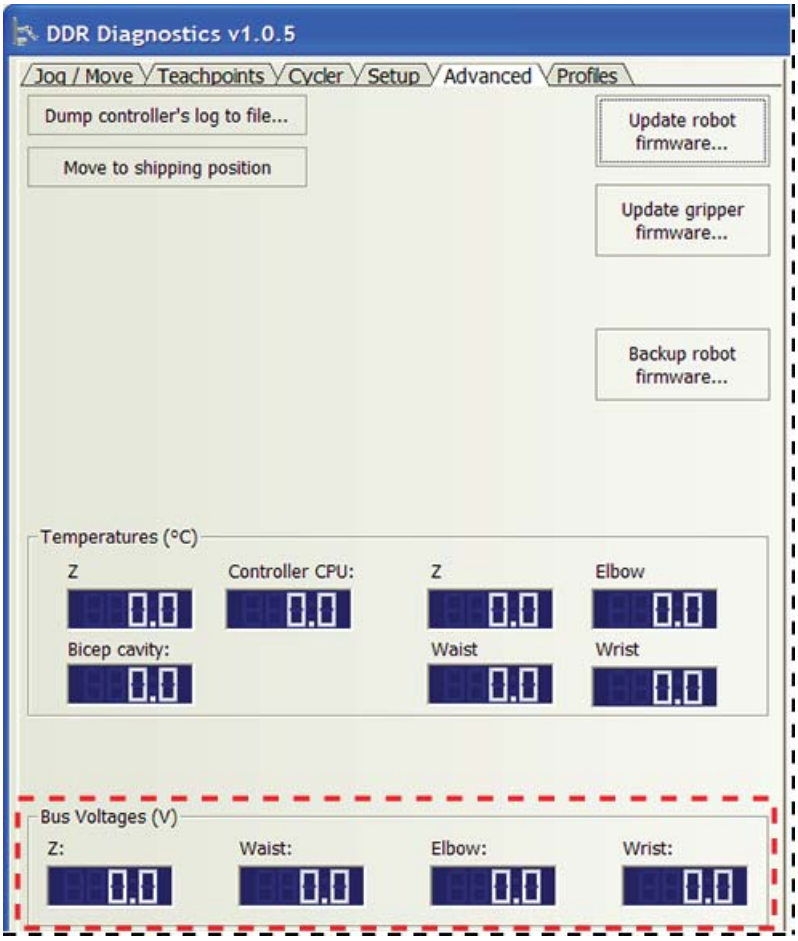
Sensors inside the robot monitor the temperature of different components. The temperatures are displayed in the **Advanced** tab, and the values are updated every 2 seconds.



If the any of the temperatures rise above the factory-set threshold value, the robot will shut down and display an error. If this happens, contact Automation Solutions Technical Support.

Checking the bus voltage

Voltages delivered to robot motors are displayed in the **Advanced** tab. The values are updated every 2 seconds.



The voltage values can be used to troubleshoot problems. For example, the bus voltage values are reduced signficantly when the motors are disabled. If this happens and you did not disable the motors, contact Automation Solutions Technical Support.

Related information

For information about...	See...
Homing the robot	"Homing the robot and grippers" on page 140
Moving the robot into the safe zone	"Moving the robot into the safe zone" on page 142
Disabling and enabling the robot motors	"Disabling and enabling the robot motors" on page 148
Changing the robot speed	"Changing the robot speed" on page 150

For information about...	See...
Stopping the robot motors	"Stopping the robot motors" on page 149
Jogging the robot	"Jogging the robot" on page 145
Opening and closing the robot grippers	"Opening and closing the robot grippers" on page 154
Checking the robot microplate sensor	"Checking the robot microplate sensor" on page 159
Viewing the log area	"Viewing the DDR Diagnostics log area" on page 174

Restoring robot settings

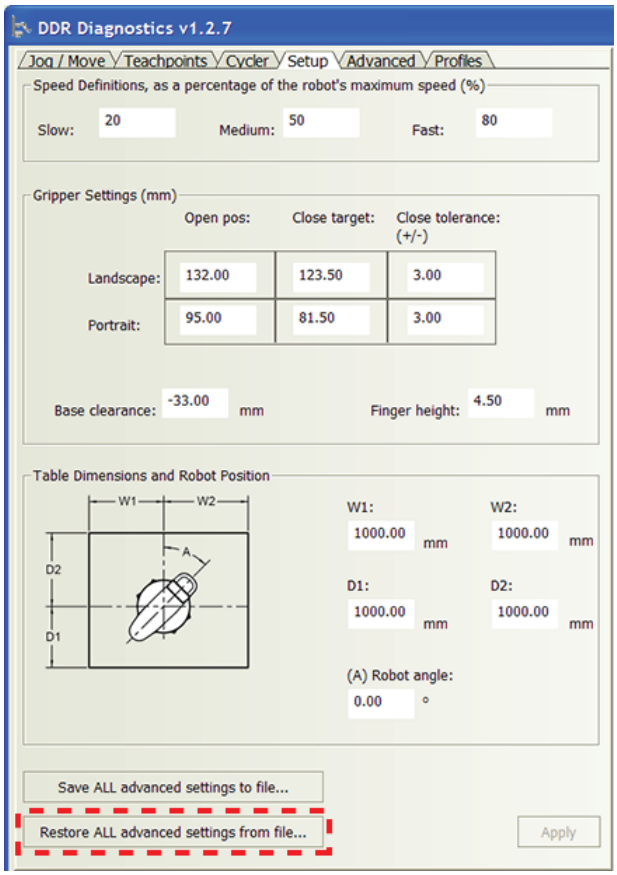
About the robot settings

In the Setup tab, when you click the Save ALL advanced settings to file, the software saves all of the values that are in the Setup tab to an XML file, also called a configuration file. If any of the settings were lost, you can recover them using the XML file.

Procedure

To restore the robot settings:

1 In the **Setup** tab, click **Restore All advanced settings from file.**



2 In the **Open** dialog box, locate and select the desired configuration file.

3 Click **Open.** The settings are restored.

Related information

For information about...	See...
Complete list of available commands you can use in DDR Diagnostics	"Quick reference" on page 219
Teachpoints tab	"Setting teachpoints" on page 77
Profiles tab	"Creating Direct Drive Robot profiles" on page 56

Updating the firmware

About this topic

The Direct Drive Robot is controlled by the following:

- *Robot firmware*. Controls the robot arm.
- *Gripper firmware*. Controls the robot grippers only.

This section explains how to check the firmware versions you are using and update both firmware.

Agilent Technologies recommends that only administrators and trained personnel use the procedures in this topic to update the Direct Drive Robot firmware.

CAUTION The procedures in this topic is for DDR robot firmware version 1.2.0 or later. For robot firmware version 1.1.x or earlier, contact Automation Solutions Technical Support before updating the firmware.

Firmware compatibility

Agilent Technologies will release compatible robot and gripper firmware together, so you should always update both the robot firmware and the gripper firmware at the same time. Failure to do so will cause an error message during initialization.

Before you start

Before you start to update the existing firmware:

- Save the existing robot settings. In the **Settings** tab, click **Save ALL advanced settings to file.**
- Make sure you have the correct files for the update process:
  - *DDR**FirmwareUpdate**_x_x_x-.zip*. Updates the existing robot firmware and retains the existing robot settings, such as robot table dimensions.
  - *DDR**Gripper**x.x.sw*. Installs the new gripper firmware.

Note: At the beginning of the update process, the software will automatically back up the current robot firmware. You do not need to manually back up the firmware.

Checking the firmware versions you are running

To check the firmware versions you are currently running:

In **DDR Diagnostics**, click the **About** button at the bottom of the dialog box. The About DDR Plugin dialog box appears and displays the robot and gripper firmware version numbers. Note the firmware version numbers.

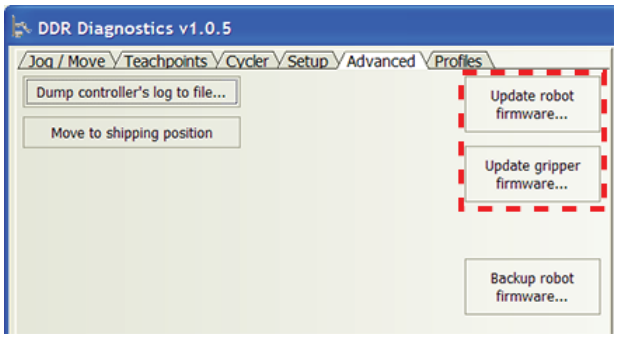
CAUTION If you have DDR robot firmware version 1.1.x or earlier, contact Automation Solutions Technical Support before updating the firmware.

Updating the robot and gripper firmware

To upgrade the robot and gripper firmware:

1 In the **Advanced** tab, click one of the following:

- **Update robot firmware**
- **Update gripper firmware**



2 In the **Open** dialog box that appears, locate and select the desired firmware file:

- DDRFirmwareUpdate_x_x_x-.zip (if you are updating the robot firmware)
- DDR_Gripperx.x.sw (if you are updating the gripper firmware)

IMPORTANT *Robot firmware update only*. If you select a file that does not have the DDRFirmware character string in the name, the update procedure will fail.

3 Click **Open.** Follow the instructions on the screen to install the firmware.

Related information

For information about...	See...
Installing new or restoring existing firmware	"Restoring existing firmware" on page 172
Initializing the profile	"Initializing the profile" on page 65
Setting up robot communication	"Setting up robot communication" on page 58
Editing profiles	"Editing and managing profiles" on page 67
Managing profiles	"Editing and managing profiles" on page 67

Backing up the robot firmware

About this topic

You should back up the robot firmware in case it becomes damaged. The backup process backs up the robot firmware only. It does not back up the gripper firmware.

This topic explains how to back up the existing robot firmware.

Agilent Technologies recommends that only administrators and trained personnel use the procedures in this topic to back up the Direct Drive Robot firmware.

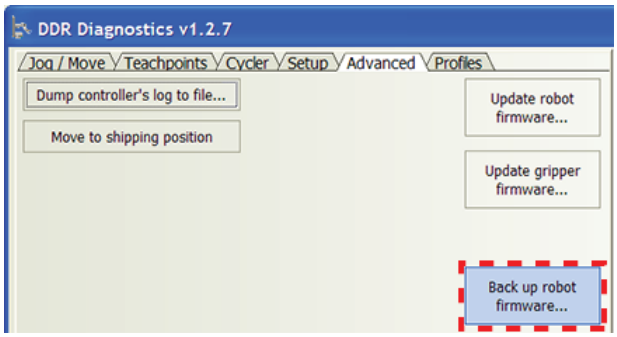
Procedure

To back up the existing firmware

1 In the **DDR Diagnostics Profiles** tab, make sure the correct profile is selected, and then click **Initialize this profile.**

IMPORTANT Communication must be established with the robot for the backup procedure to be successful.

2 In the **DDR Diagnostics Advanced** tab, click **Backup firmware.**



3 In the Save As dialog box that opens:

a Type a name for the backup file.

IMPORTANT The file name must contain the character string DDRFirmware. The software uses the string to identify the file during firmware updates. For example, a valid name is DDRFirmwareBackup_20100310_112905.zip.

b Use the default backup file location, or select a different location. The default location is C:\Program Files\Agilent Technologies\Settings\DDR\Firmware Backup.

4 Click **Save.** The robot firmware is saved in a ZIP file.

Related information

For information about...	See...
Updating the firmware	“Updating the firmware” on page 168
Initializing the profile	“Initializing the profile” on page 65
Setting up robot communication	“Setting up robot communication” on page 58
Editing profiles	“Editing and managing profiles” on page 67
Managing profiles	“Editing and managing profiles” on page 67

Restoring existing firmware

About this topic

In case the firmware files become damaged and the robot no longer operates, you can use a backup copy of the firmware to restore robot operation.

This topic explains how to use firmware backup files to restore robot operation.

Agilent Technologies recommends that only administrators and trained personnel use the procedures in this topic to restore the Direct Drive Robot firmware.

CAUTION Use the instructions in this topic only if you have determined the firmware files are damaged. If you are not sure, contact Automation Solutions Technical Support for assistance.

CAUTION Do not use this procedure to update firmware. The restoration procedure will install the backup firmware and erase existing robot settings.

CAUTION The procedure in this topic is for DDR robot firmware version 1.2.0 or later. For robot firmware version 1.1.x or earlier, contact Automation Solutions Technical Support.

Before you start

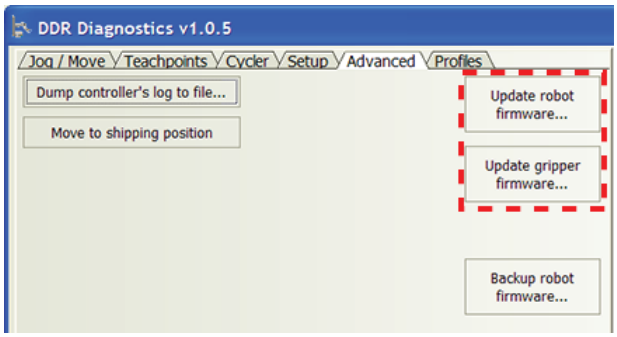
Make sure you have the correct files for the procedure:

- *DDRFirmware**Backup**_<date>.zip*. The backup copy of the existing robot firmware.
- *DDR**Gripper**x.x.sw*. The gripper firmware file that accompanies the robot firmware update file from Agilent Technologies.
- <filename>.xml. The XML file that contains the robot settings, such as robot table dimensions, gripper settings, and so on. This file is created when you click **Save ALL advanced settings to file** in the **Setup** tab.

Installing the robot and gripper firmware

To restore or install the robot and gripper firmware:

1 In the **Advanced** tab, click one of the following:
   - **Update robot firmware**
   - **Update gripper firmware**



2 In the **Open** dialog box that appears, locate and select the desired firmware file:

- DDRFirmwareBackup_<date>.zip (if you are restoring the robot firmware using a backup copy)
- DDR_Gripperx.x.sw (if you are installing the gripper firmware)

IMPORTANT *Robot firmware update only.* If you select a file that does not have the DDRFirmware character string in the name, the procedure will fail.

3 Click **Open.** Follow the instructions on the screen to install the firmware.

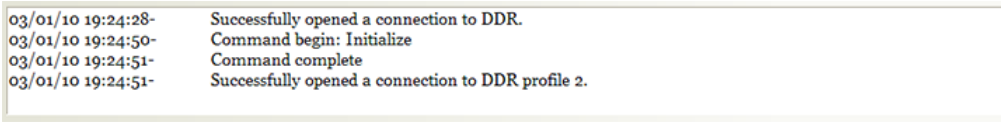
4 To restore the robot settings, in the **Settings** tab, click **Restore ALL advanced settings from file.**

Related information

For information about...	See...
Initializing the profile	“Initializing the profile” on page 65
Setting up robot communication	“Setting up robot communication” on page 58
Editing profiles	“Editing and managing profiles” on page 67
Managing profiles	“Editing and managing profiles” on page 67

Viewing the DDR Diagnostics log area

The log area at the bottom of the dialog box shows the status of the commands or actions issued while you are working in the dialog box.


03/01/10 19:24:28- Successfully opened a connection to DDR.
03/01/10 19:24:50- Command begin: Initialize
03/01/10 19:24:51- Command complete
03/01/10 19:24:51- Successfully opened a connection to DDR profile 2.

Related information

For information about...	See...
Homing the robot	"Homing the robot and grippers" on page 140
Moving the robot into the safe zone	"Moving the robot into the safe zone" on page 142
Disabling and enabling the robot motors	"Disabling and enabling the robot motors" on page 148
Changing the robot speed	"Changing the robot speed" on page 150
Stopping the robot motors	"Stopping the robot motors" on page 149
Jogging the robot	"Jogging the robot" on page 145
Opening and closing the robot grippers	"Opening and closing the robot grippers" on page 154
Checking the robot microplate sensor	"Checking the robot microplate sensor" on page 159
Changing the robot display	"Changing the robot display" on page 161

Saving the controller log to file

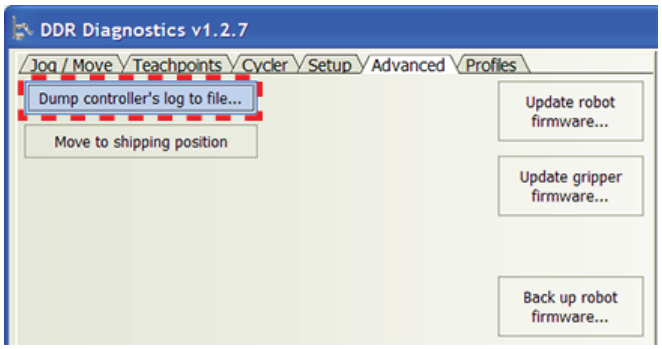
About the robot controller

The robot controller log is primarily used for troubleshooting. When contacting Automation Solutions Technical Support for assistance, you might be asked to send the log file.

Procedure

To save the controller log to a file:

1 In the **DDR Diagnostics Advanced** tab, click **Dump controller's log to file.**



2 In the **Save As** dialog box, select a location where you want to save the file and provide a name for the file.

3 Click **Save.** The log is saved as a TXT file.

Related information

For information about...	See...
Homing the robot	"Homing the robot and grippers" on page 140
Moving the robot into the safe zone	"Moving the robot into the safe zone" on page 142
Disabling and enabling the robot motors	"Disabling and enabling the robot motors" on page 148
Changing the robot speed	"Changing the robot speed" on page 150
Stopping the robot motors	"Stopping the robot motors" on page 149
Jogging the robot	"Jogging the robot" on page 145
Opening and closing the robot grippers	"Opening and closing the robot grippers" on page 154

For information about...	See...
Checking the robot microplate sensor	"Checking the robot microplate sensor" on page 159
Changing the robot display	"Changing the robot display" on page 161

8 Maintaining the robot

This chapter explains how to maintain the Direct Drive Robot to optimize performance.

This chapter contains the following topics:

- "Routine maintenance" on page 178
- "Cleaning the robot gripper pads" on page 179
- "Replacing robot gripper pads" on page 181
- "Tightening the gripper pad screws" on page 183
- "Replacing robot grippers" on page 185
- "Replacing fuses in power supply G5411-60010" on page 190
- "Replacing fuses in power supply G5411-60005" on page 192

Routine maintenance

Maintenance tasks

WARNING **Only administrators and trained personnel should perform the maintenance procedures in this chapter.**

WARNING **Always turn off the robot and shut down the system before performing any maintenance procedure. See "Turning on and turning off the robot" on page 46 and the system user documentation.**

Task	Frequency	Procedure
Clean up spills on any part of the robot after a protocol run.	Immediately	Use a clean soft cloth to remove the spill.
Inspect gripper pads for dirt, wear, tear, and cracks. Clean the gripper pads. Replace the gripper pads if necessary.	Monthly	See one of the following: • "Cleaning the robot gripper pads" on page 179 • "Replacing robot gripper pads" on page 181
Tighten the gripper pad screws.	Monthly	See "Tightening the gripper pad screws" on page 183.

For preventive maintenance service, contact Automation Solutions Technical Support.

Related information

For information about...	See...
Shutdown procedure	"Turning on and turning off the robot" on page 46
Safety	*Direct Drive Robot Site Preparation and Safety Guide*
Replacing robot grippers	"Replacing robot grippers" on page 185
Replacing fuses	• "Replacing fuses in power supply G5411-60010" on page 190 • "Replacing fuses in power supply G5411-60005" on page 192
Assistance with maintenance procedures	"Reporting problems" on page 217

Cleaning the robot gripper pads

About this topic

Dirt on robot gripper pads can cause the robot to drop labware. You should inspect the gripper pads for dirt monthly to ensure optimal performance.

This topic explains how to clean the robot gripper pads.

WARNING **Only administrators and trained personnel should perform the procedures in this topic.**

Materials and tools

Make sure you have a soft cloth and access to clean water.

Before you start

Make sure you:

1. Use DDR Diagnostics to move the robot to a position where you can easily access the robot grippers.
2. Turn off the robot and the system.
3. Disconnect the power cord from the robot power supply.

Procedure

WARNING **Always turn off the robot and shut down the system before performing any maintenance procedure.**

WARNING **Always disconnect the power cord from the robot power supply before performing any maintenance procedure.**

To clean the robot gripper pads:

1. Dampen a soft cloth with water.

   CAUTION Do not use alcohol or alcohol-based cleaning solutions. Alcohol and alcohol-based solutions can damage the gripper pads.

2. Gently rub the gripper pads to remove dirt.
3. Make sure the gripper pads are dry before using the system.

Related information

For information about...	See...
Robot shutdown procedure	"Turning on and turning off the robot" on page 46

For information about...	See...
System shutdown procedure	System user documentation
Safety	*Direct Drive Robot Site Preparation and Safety Guide*
DDR Diagnostics	"Using DDR Diagnostics" on page 137

Replacing robot gripper pads

About this topic

Gripper pads can become worn with use. Agilent Technologies recommends that you check the gripper pads monthly and replace them if necessary.

This topic explains how to replace the robot gripper pads.

WARNING **Only administrators and trained personnel should perform the procedures in this topic.**

Materials and tools

Make sure you use the following materials and tools supplied with the robot:

- Spare pair of robot gripper pads
- Star-head cap screws (6)
- Star-head wrench
- Thread-locking solution

Before you start

Make sure you:

1. Use DDR Diagnostics to move the robot to a position where you can easily access the robot grippers.
2. Turn off the robot and the system.
3. Disconnect the power cord from the robot power supply.

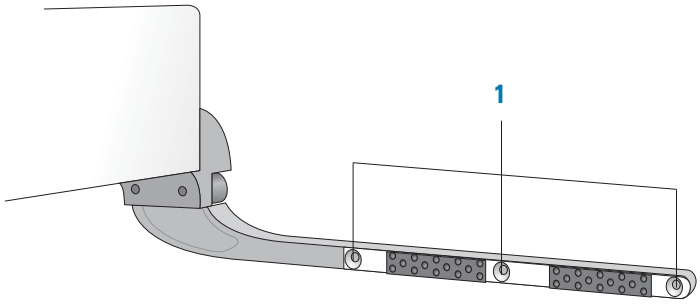
Procedure

WARNING **Always turn off the robot and shut down the system before performing any maintenance procedure.**

WARNING **Always disconnect the power cord from the robot power supply before performing any maintenance procedure.**

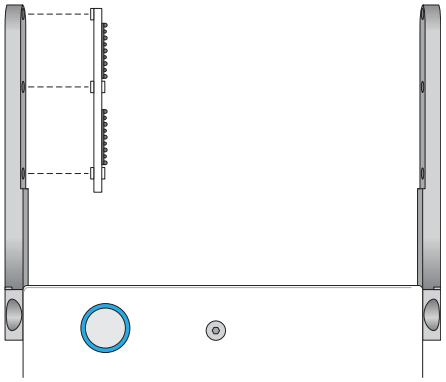
To replace a robot gripper pad:

1. Using the star-head wrench, remove the three cap screws that are holding the pad to the gripper finger (1).



2 Pull the pad from the gripper finger.

3 Align the new pad on the inside of the grippers as shown, and then press it against the gripper finger so that the pad is held in place.



4 Add a tiny drop of thread-locking solution across the thread of each screw. The solution functions like glue to prevent the screws from becoming loose.

5 Insert the three cap screws in the gripper finger, and then use the star wrench to tighten the screws.

Related information

For information about...	See...
Direct Drive Robot component names	"Hardware components" on page 4
Robot shutdown procedure	"Turning on and turning off the robot" on page 46
System shutdown procedure	System user documentation
Safety	*Direct Drive Robot Site Preparation and Safety Guide*
DDR Diagnostics	"Using DDR Diagnostics" on page 137

Tightening the gripper pad screws

About the gripper pad screws

The gripper pad screws might becomes loose with use. Agilent Technologies recommends that you check the gripper pad screws monthly and tighten them as necessary.

WARNING **Only administrators and trained personnel should perform the procedures in this topic.**

Materials and tools

Make sure you use the following materials and tools supplied with the robot:

- Star-head wrench
- Thread-locking solution

Before you start

Make sure you:

1. Use DDR Diagnostics to move the robot to a position where you can easily access the robot grippers.
2. Turn off the robot and the system. See "Turning on and turning off the robot" on page 46 and the system user documentation.
3. Disconnect the power cord from the robot power supply.

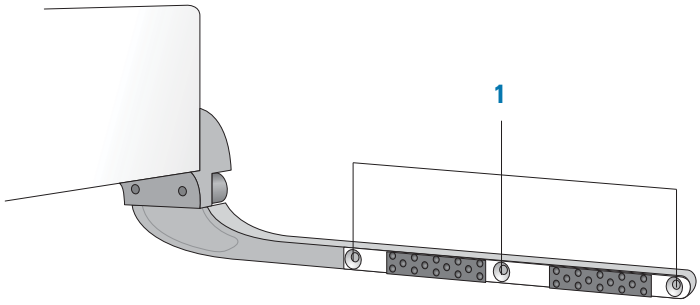
Procedure

WARNING **Always turn off the robot and shut down the system before performing any maintenance procedure.**

WARNING **Always disconnect the power cord from the robot power supply before performing any maintenance procedure.**

To tighten the gripper pad screws:

1. Using the star-head wrench, remove the screws.
2. Add a small drop of thread-locking solution across the thread of each screw. The solution functions like glue to prevent the screws from becoming loose.
3. Using the star-head wrench, turn the screws to tighten them (1).



4 Allow the thread-locking solution to dry before operating the robot.

Related information

For information about...	See...
Robot shutdown procedure	"Turning on and turning off the robot" on page 46
System shutdown procedure	System user documentation
Safety	*Direct Drive Robot Site Preparation and Safety Guide*
DDR Diagnostics	"Using DDR Diagnostics" on page 137

Replacing robot grippers

About this topic

You can replace the robot grippers under the following circumstances:

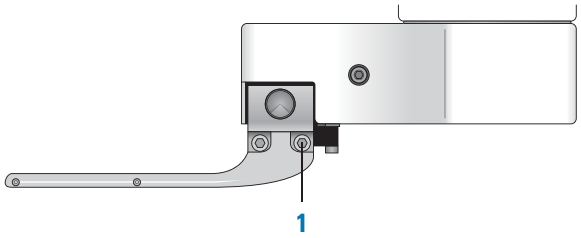
- One or both grippers are damaged.
- You want to use a different set of grippers to accommodate a specific teachpoint requirement. For example, a teachpoint at a particular device might be recessed more than in other devices. So the gripper fingers must be vertically longer to reach the labware at that teachpoint. (For the list of different gripper types available, contact Automation Solutions Customer Service.)

This topic explains how to replace the robot grippers.

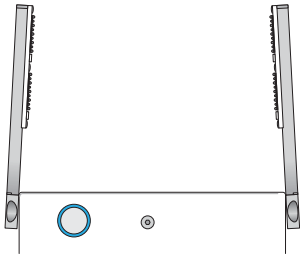
WARNING **Only administrators and experienced personnel should perform the procedures in this topic.**

About the shim washers

Two ultra-thin washers are installed between each gripper and the robot hand, behind the screw at the back end of the gripper (1).



The washers are used to ensure the tips of the grippers point slightly inward to ensure optimal grip performance. The following diagram exaggerates the inward positioning.



Note: The number of washers used depends on the robot setup. Typically, only two washers are used behind each gripper. However, in some cases, many washers might be used to optimize grip performance.

CAUTION Because the washers are especially thin and light, it might be easy to lose them during the replacement procedure.

Materials and tools

Make sure you have the following:

- Grippers you want to install
- 2.5-mm hex wrench
- Standard caliper

Before you start

Make sure you:

1. Use DDR Diagnostics to move the robot to a position where you can easily access the robot grippers.
2. Turn off the robot and the system.
3. Disconnect the power cord from the robot power supply.

Procedure

The replacement procedure involves the following:

1. "Replacing the grippers" on page 186
2. "Recording the gripper height" on page 187
3. "Recording the base clearance z-axis coordinate" on page 187

Replacing the grippers

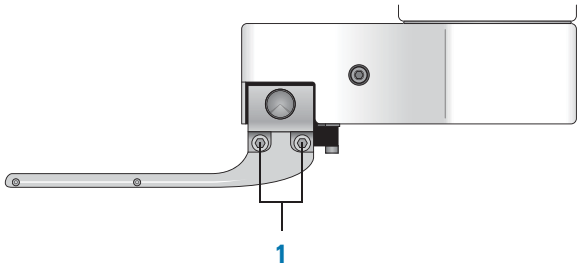
WARNING **Always turn off the robot and shut down the system before performing any maintenance procedure.**

WARNING **Always disconnect the power cord from the robot power supply before performing any maintenance procedure.**

To replace the robot grippers:

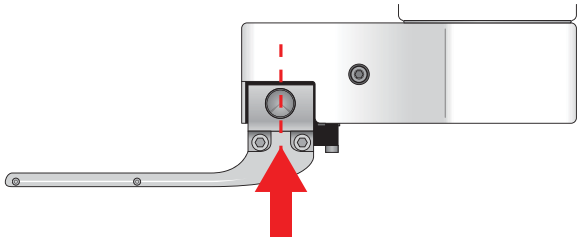
1. Using the 2.5-mm hex wrench, remove the two screws that are holding the gripper to the robot hand (1).

   IMPORTANT As you loosen the screw at the back end of the gripper, hold a hand under the screw to catch the falling washers.



2. Remove the gripper.
3. Place the washers behind the new gripper, aligning them with the screw hole at the back end, and then insert a screw into the hole to hold the washers in place.

4 Position the new gripper finger at the hand as shown, and push upward so that the top of the gripper is pressed securely against the bottom of the gripper mount.



5 While pushing upward on the gripper:

   a Tighten the screw at the back end of the gripper.

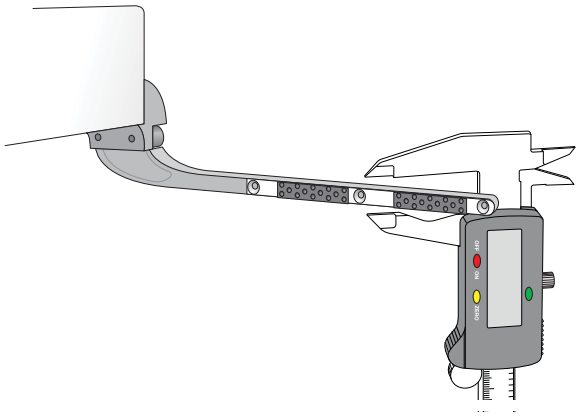
   b Insert and tighten the remaining screw in the gripper.

6 Repeat steps 1 through 5 to replace the second gripper.

Recording the gripper height

To record the gripper height:

1 Using the caliper, measure the height of one of the grippers. Take the measurement at the middle of the gripper pad, as the following diagram shows.



2 In **DDR Diagnostics,** click the **Setup** tab.

3 In the **Gripper Settings** area, type the gripper height value you determined in step 1 in the **Finger height** box.

Recording the base clearance *z*-axis coordinate

The base clearance value is the *z*-axis coordinate at which the bottom of the grippers touch the top of the base. Knowing that *z*-coordinate prevents the robot from colliding with the base.

To record the z-axis coordinate:

1 Reconnect the power cord to the power supply and turn on the robot.

WARNING **Keep out of the system while the robot is starting up.**

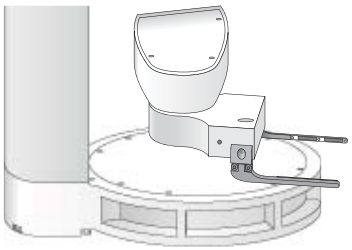
2 In **DDR Diagnostics,** initialize the robot profile you want to use, and then click the **Jog/Move** tab.

3 Using the jog commands, position the robot hand so that it is directly above the base.

WARNING **Keep out of the system while the robot is moving.**

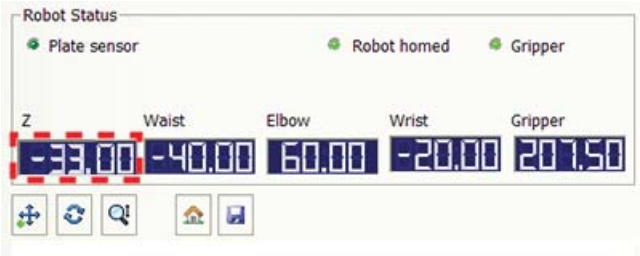
4 Jog the robot down along the *z*-axis until the bottom of the grippers touch the top of the base.

WARNING **Keep out of the system while the robot is moving.**

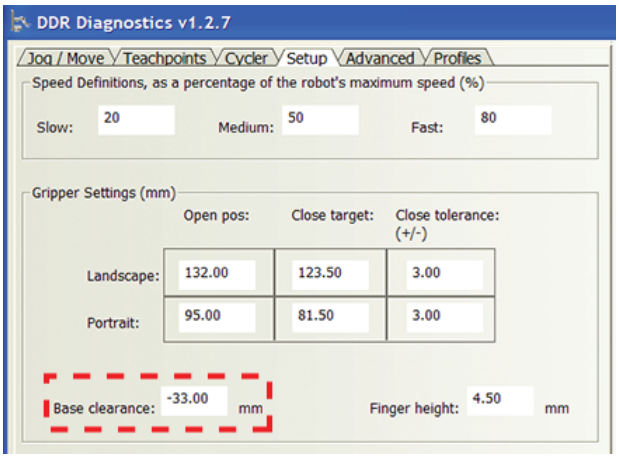


5 In the **Robot Status** area, note the *z*-axis coordinate value.

Note: The *z*-axis 0 value is approximately 15 cm above the base. The *z*-axis value where the grippers touch the base is typically below the 0 value, so it is negative.



6 Click the **Setup** tab, and type the *z*-axis coordinate value in the **Base clearance** box.



Related information

For information about...	See...
Direct Drive Robot component names	“Hardware components” on page 4
Robot shutdown procedure	“Turning on and turning off the robot” on page 46
System shutdown procedure	System user documentation
Safety	*Direct Drive Robot Site Preparation and Safety Guide*
Contacting Automation Solutions Technical Support	“Reporting problems” on page 217

Replacing fuses in power supply G5411-60010

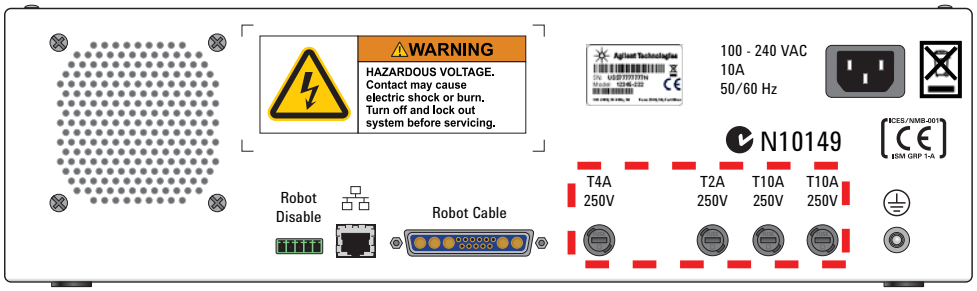
About this topic

This topic explains how to replace the fuses in the robot power supply (G5411-60010).

WARNING **Only administrators and experienced personnel should perform the procedure in this topic. Alternatively, contact Automation Solutions Technical Support for assistance.**

Fuse location

The Direct Drive Robot power supply (G5411-60010) houses four fuses:



Fuse housing label	Function	Fuse rating (time-delayed)
T4A 250V	24-V robot fuse	4 A, 250 V
T2A 250V	Logic power/switch fuse	2 A, 250 V
T10A 250V	AC mains fuse, line (left)	10 A, 250 V
T10A 250V	AC mains fuse, neutral (right)	10 A, 250 V

Materials and tools

Make sure you have the following:

- Flat-head screwdriver (any size)
- Replacement fuse(s)

Before you start

Make sure you:

1. Turn off the robot and the system.
2. Disconnect the power cord from the robot power supply.

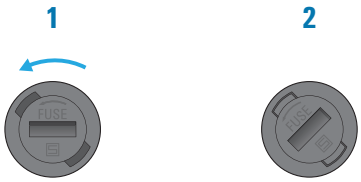
Procedure

WARNING **Always turn off the robot and shut down the system before performing any maintenance procedure.**

WARNING **Always disconnect the power cord from the robot power supply before performing any maintenance procedure.**

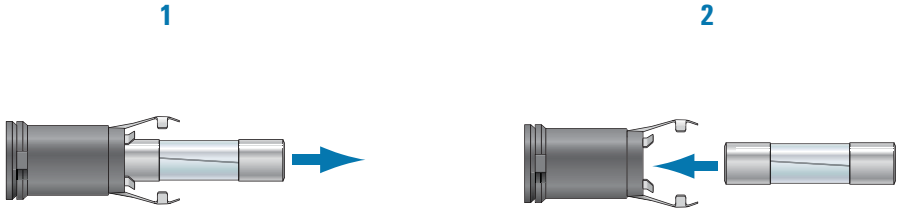
To replace one of the fuses:

1 Using the flat-head screwdriver, turn the fuse holder counterclockwise one-eighth turn (1). The fuse holder moves outward (2).



2 Remove the fuse holder from the housing.

3 Pull out the spent fuse (1) and insert the new fuse (2).



4 Insert the fuse and holder back into the housing.

5 While pressing the fuse holder into the housing, turn the fuse holder clockwise one-eight turn using the flat-head screwdriver.

Related information

For information about...	See...
Direct Drive Robot component names	"Hardware components" on page 4
Robot shutdown procedure	"Turning on and turning off the robot" on page 46
System shutdown procedure	System user documentation
Safety	*Direct Drive Robot Site Preparation and Safety Guide*
Contacting Automation Solutions Technical Support	"Reporting problems" on page 217

Replacing fuses in power supply G5411-60005

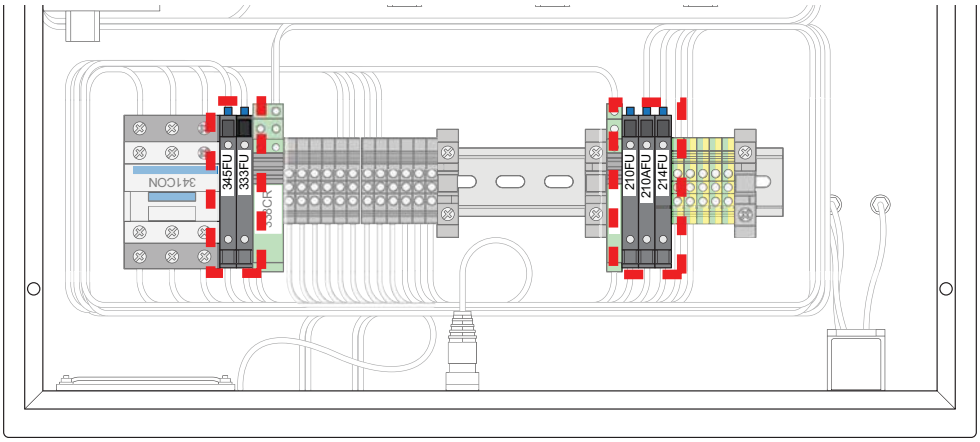
About this topic

This topic explains how to replace the fuses in the robot power supply (G5411-60005).

WARNING **Only administrators and experienced personnel should perform the procedure in this topic. Alternatively, contact Automation Solutions Technical Support for assistance.**

Fuse location

The Direct Drive Robot power supply (G5411-60005) houses five fuses:



Fuse housing label	Function	Fuse rating (all are time-delayed)
345FU	24 V emergency stop pendant/cable fuse	0.8 A, 250 V
333FU	24 V robot fuse	5 A, 250 V
210FU	AC mains fuse	10 A, 250 V
210AFU	AC mains fuse	10 A, 250 V
214FU	Logic power/switch fuse	2 A, 250 V

Materials and tools

Make sure you have the following:

- Anti-static wrist band
- 2-mm hex wrench (supplied with the robot)
- Replacement fuse(s)

Before you start

Make sure you:

1 Turn off the robot and the system.

2 Disconnect the power cord from the robot power supply.

Procedure

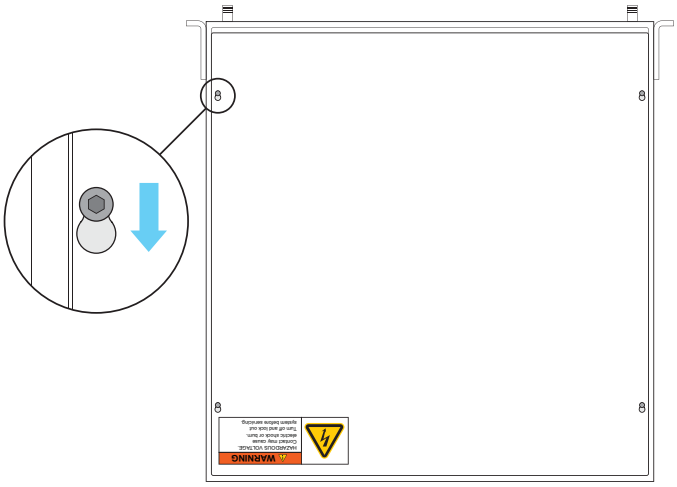
WARNING **Always turn off the robot and shut down the system before performing any maintenance procedure.**

WARNING **Always disconnect the power cord from the robot power supply before performing any maintenance procedure.**

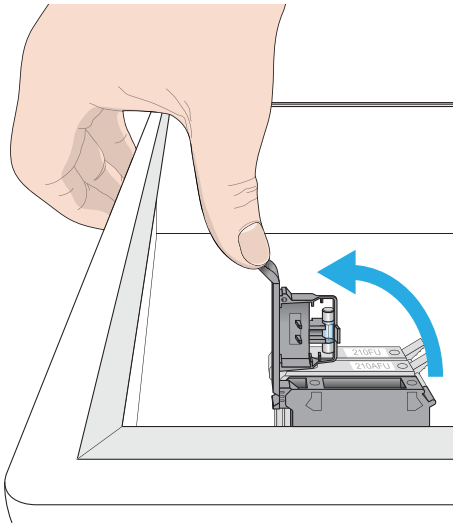
CAUTION Be sure to wear the anti-static wrist band and connect the band to ground before removing the power supply cover.

To replace one of the fuses:

1 Without removing them, loosen the four screws at the top of the power supply, slide the lid as shown, and then lift the lid to remove it.

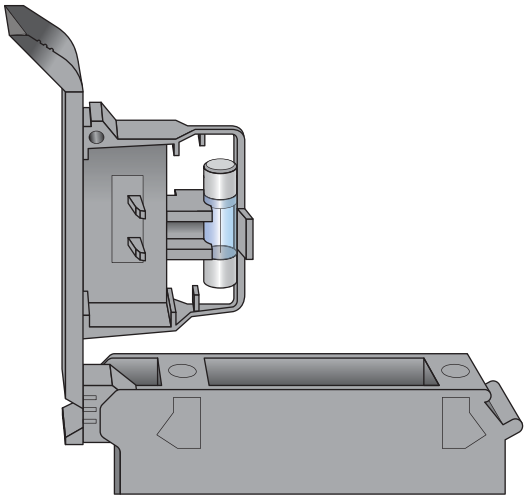


2 Lift up the cover of the fuse you want to replace.



3 Remove the spent fuse. To do this, push the fuse from behind.

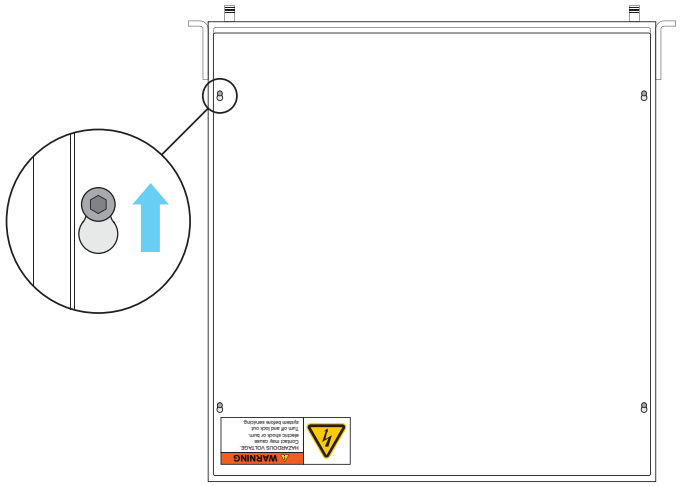
4 Install the new fuse in the housing. Make sure the glass portion of the fuse is vertically centered in the holder as shown.



5 Press closed the fuse cover.

6 Place the lid on the power supply.

7 Slide the lid as shown, and then insert and tighten the four screws to secure the lid.



8 Connect the power cord from the back of the power supply.

9 Turn on the robot and system.

Related information

For information about...	See...
Direct Drive Robot component names	"Hardware components" on page 4
Robot shutdown and startup procedure	"Turning on and turning off the robot" on page 46
System shutdown and startup procedure	System user documentation
Safety	*Direct Drive Robot Site Preparation and Safety Guide*
Contacting Automation Solutions Technical Support	"Reporting problems" on page 217

9 Troubleshooting robot problems

This chapter explains how to troubleshoot the Direct Drive Robot. This chapter contains the following topics:

- "Recovering from an emergency stop" on page 198
- "Resolving robot initialization errors" on page 200
- "Recovering from servo errors" on page 201
- "Troubleshooting hardware problems" on page 203
- "Troubleshooting error messages" on page 208
- "Reporting problems" on page 217

Recovering from an emergency stop

About this topic

This topic explains how to recover from an emergency stop after you pressed the red button on the emergency stop pendant.

After you pressed the emergency stop button

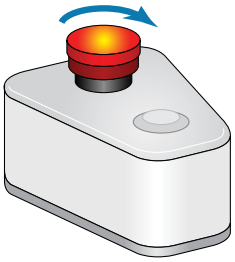
After pressing the emergency stop button, you must restore the system for normal operation.

IMPORTANT You cannot resume or recover a protocol run after pressing the emergency stop button. You will need to rerun the protocol after restoring the system for normal operation.

Before you restore the system, make sure you remove labware that might have been dropped during the emergency stop. Also remove labware at teachpoints or other locations.

To restore the Direct Drive Robot after an emergency stop:

1 Restore power to the robot. To do this, turn the red button on the emergency stop pendant clockwise. The spring-loaded button pops up.



2 If you stopped a protocol run in an emergency, select one of the following in each of the device dialog boxes to restore the device for normal operation:

Selection	Description
Diagnostics	Opens the device diagnostics dialog box. *Note:* This selection is available only when you are in the middle of a protocol run and not while you are already in the device diagnostics software.
Retry	Attempts to restart the current command or task in the run.
Ignore and continue	Ignores the current command or task and continues to the next command or task in the protocol sequence.
Abort	Aborts the current command or task in the run. Select Abort if you have determined that the protocol run is not recoverable.

3 If there is labware in the Direct Drive Robot robot gripper, release it and move it back to the pickup location. To do this:
   a Determine the location from which the labware was picked up.
   b In the **Robot Error** dialog box, click **Diagnostics.**
   c Hold the labware in your hand so that the labware does not drop when you release it from the robot grippers.
   d Click **Open** in the **DDR Diagnostics Jog/Teach** tab to release the labware to your hand.
   e Place the labware at the pickup location.
4 Click **Abort Process** in the **Stop** dialog box.
5 Exit and restart the VWorks software. Communication with the robot is re-established.

Related information

For information about...	See...
Pausing and resuming protocol runs	*VWorks Automation Control User Guide*
Shutting down the system	System user documentation
Turning off the robot	"Turning on and turning off the robot" on page 46
Using commands in Robot Diagnostics	"Using DDR Diagnostics" on page 137
Safety	*BioCel System Safety Guide*
Reporting problems	"Reporting problems" on page 217

Resolving robot initialization errors

About the robot initialization process

Robot initialization occurs:

- When you click **Initialize all devices**, or when you select the Direct Drive Robot and click **Initialize selected devices** in the device file.
- When you click **Initialize this profile** in DDR Diagnostics.

During the robot initialization process, the software establishes communication with the robot.

Resolving initialization errors

WARNING **Only administrators and experienced personnel should perform the procedures in this section.**

If a problem occurs during initialization, an error message appears and explains the problem.

To resolve the problem:

1. Make sure the robot is turned on.
2. Make sure the robot cable is connected correctly.
3. Make sure the Ethernet cable is connected correctly.
4. Check the device profile to make sure it is set up correctly for communication.
5. If applicable, follow the instructions in the error message to fix the communication problem.
6. Click Retry to re-initialize the device.
7. If the problem persists, contact Automation Solutions Technical Support.

Related information

For information about...	See...
Turning on the robot	“Turning on and turning off the robot” on page 46
Editing the profile	“Editing and managing profiles” on page 67
Troubleshooting error messages	“Troubleshooting error messages” on page 208
Reporting problems	“Reporting problems” on page 217

Recovering from servo errors

About this topic

This topic explains how to recover from servo errors.

Causes of servo errors

A servo system controls the robot's motions. The servo cuts power to the robot if it encounters resistance to movement that is slightly higher than that expected from the inertia of the robotic arm holding a labware. When the power is cut, a servo error is generated.

Most servo errors occur when the labware being carried crashes into another labware that is on a device.

Procedure

WARNING Only administrators and experienced personnel should perform the procedures in this section.

To recover from a servo error:

1. Check the system to determine the cause of the collision and remove the obstruction. For example, it might be a labware from a previous run.
2. Check the labware that is held by the robot to make sure it is not damaged and that its contents are not spilled.
3. Make sure the labware did not move in the robot gripper during the collision.
4. If the labware has not moved in the robot gripper and was not damaged during the collision, in the error message dialog box, click one of the following:

Selection	Description
Diagnostics	Opens the device diagnostics dialog box. *Note:* This selection is available only when you are in the middle of a protocol run and not while you are already in the device diagnostics software.
Retry	Attempts to restart the current command or task in the run.
Ignore and continue	Ignores the current command or task and continues to the next command or task in the protocol sequence.
Abort	Aborts the current command or task in the run. Select Abort if you have determined that the protocol run is not recoverable.

5 If the labware has moved during the collision or was damaged, in the error message dialog box, click **Diagnostics** and move the labware manually:
   a Move the robot to a position that is easy for you to access.
   b While holding the labware with your hand, click **Open** in the **DDR Diagnostics Jog/Teach** tab to release the labware to your hand. The robot releases the labware.
   c Place the labware at the destination location manually.
   d Close **DDR Diagnostics**.
   e Click in the next error message dialog box, and then click **Ignore and continue.**
6 If the crash was severe, home the robot.

Related information

For information about...	See...
Opening the robot grippers	“Opening and closing the robot grippers” on page 154
Homing the robot	“Homing the robot and grippers” on page 140
Verifying teachpoints	“Verifying teachpoints” on page 109
Reporting problems	“Reporting problems” on page 217

Troubleshooting hardware problems

About this topic

This topic lists the following commonly encountered hardware problems, the causes of the problems, and ways to resolve the problems:

- "Communication or power problems" on page 203
- "Gripper, labware, or teachpoint problems" on page 205
- "Homing problems" on page 207

If you are still experiencing problems with the Direct Drive Robot after trying the solutions, contact Automation Solutions Technical Support.

WARNING **Only administrators and experienced personnel should perform the procedures in this section.**

Communication or power problems

Problem	Cause	Solution
The robot does not turn on.	The system electrical requirements are not met.	Make sure the system electrical requirements are met. See "Electrical requirements" on page 27.
	The Direct Drive Robot is not connected to the power source.	Connect the Direct Drive Robot to the power source. See "Power supply" on page 7.
	One or more of the robot fuses are blown.	Check the Logic and Motor Power lights on the front of the power supply to see which fuse(s) are blown, then replace the blown fuse(s). See "Replacing fuses in power supply G5411-60010" on page 190 or "Replacing fuses in power supply G5411-60005" on page 192. If the fuses are blown immediately after replacement, stop using the robot and contact Automation Solutions Technical Support.

Problem	Cause	Solution
The Logic light on the front of the power supply does not turn on.	The robot power is not turned on.	Turn on the robot. See "Turning on and turning off the robot" on page 46.
	The robot power cable is not connected to the power supply or the power source.	Connect the power cable to the power supply and the power source. See "Installing the robot" on page 42.
	One or more of the following fuses might be blown: AC main fuse, switch fuse, or cable fuse.	Replace the fuse(s). See "Replacing fuses in power supply G5411-60010" on page 190 or "Replacing fuses in power supply G5411-60010" on page 190. If the fuses are blown immediately after replacement, stop using the robot and contact Automation Solutions Technical Support.
	If you turn on the robot, the Logic light does not turn on but you can still hear the fan in the power supply, then the indicator light bulb is blown.	Replace the light bulb. Contact Automation Solutions Technical Support for assistance.
The Motor Power light on the front of the power supply does not turn on.	The robot profile is not initialized.	Initialize the profile.
	The Logic light is also off.	Troubleshoot the Logic light problems.
	The emergency stop button is pressed down.	Recover from the emergency stop. See "Recovering from an emergency stop" on page 198.
	The robot communications cable is not connected to the power supply or the robot.	Connect the communications cable to the power supply and the robot. See "Installing the robot" on page 42.
	The Robot fuse is blown.	Replace the Robot fuse. See "Replacing fuses in power supply G5411-60010" on page 190 or "Replacing fuses in power supply G5411-60010" on page 190. If the fuse is blown immediately after replacement, stop using the robot and contact Automation Solutions Technical Support.
	If you turn on the robot, the Logic light turns on, the Motor Power light remains off, but you can still jog the robot, then the indicator light bulb is blown.	Replace the light bulb. Contact Automation Solutions Technical Support for assistance.

Problem	Cause	Solution
The blue light on the robot hand continues to blink after the robot has finished its startup routine.	The robot configuration file might be corrupt.	Reload the backup copy of the robot and gripper firmware and try again. See "Restoring existing firmware" on page 172 for instructions.
The blue light on the robot hand remains on after the robot has finished its startup routine.	The gripper firmware (ASB code) might be corrupt.	Reload the backup copy of the robot and gripper firmware and try again. See "Restoring existing firmware" on page 172 for instructions.

Gripper, labware, or teachpoint problems

Problem	Cause	Solution
Labware drops or is held loosely by the robot.	The labware definition for the microplate type might contain incorrect information.	Check the labware definition for errors.
	The Grip torque parameter value is incorrect for the labware.	In Labware Editor, change the Grip torque value for the labware.
	The Gripper offset range is incorrect.	In the Labware Editor and the Direct Drive Robot Diagnostics, change the Gripper Offset Range values.
	The robot gripper pads are dirty or worn.	Clean or replace the robot gripper pads. See "Cleaning the robot gripper pads" on page 179 or "Replacing robot gripper pads" on page 181.
	The gripper pads are loose.	Tighten the screws that are holding the pads to the grippers.
	Shim washers are missing or installed incorrectly beneath the screws at the back end of the grippers.	Check and make sure the shim washers are in place. See "About the shim washers" on page 185.
	The grippers are damaged.	See "Replacing robot gripper pads" on page 181
Labware bends when held by the robot.	The Grip torque parameter value is incorrect for the labware.	In Labware Editor, change the Grip torque value for the labware.
The robot is not moving to and from the teachpoints accurately.	The robot axes need to be recalibrated.	Home the robot. See "Homing the robot and grippers" on page 140.
	The teachpoint coordinates or orientations are inaccurate. The approach height value might be incorrect.	Verify and edit the teachpoint. See "Verifying teachpoints" on page 109.

Problem	Cause	Solution
The robot is unable to place labware at the target location accurately.	The target location teachpoint is incorrect.	Verify and edit the teachpoints. See "Verifying teachpoints" on page 109.
	The teachpoint of the previously scheduled device is incorrect.	Verify and edit the teachpoints. See "Verifying teachpoints" on page 109.
	The target device was moved or reconfigured and the teachpoint was not updated.	Verify and edit the teachpoints. See "Verifying teachpoints" on page 109.
	Approach height setting is incorrect.	Check the approach height setting.
	The labware might be damaged or deformed.	Replace the damaged or deformed labware.
	The robot gripper pads are dirty or worn.	Clean or replace the robot gripper pads. See "Cleaning the robot gripper pads" on page 179 or "Replacing robot gripper pads" on page 181.
	The robot grippers are damaged.	Contact Automation Solutions Technical Support to replace the robot grippers.
	Incorrect gripper offset range is specified.	Check and correct the gripper offset ranges for the labware, the pick location, and the place location. See "Setting the gripper offset parameters" on page 102.
The robot placed the labware such that the A1 well is in the wrong orientation.	The incorrect A1-well orientation is specified for the teachpoint.	In the teachpoint file, verify the A1-well orientation specification. Change the specification if necessary. See "Specifying the A1-well orientation" on page 94.
The robot collides with devices or obstacles when moving from teachpoint to teachpoint.	The incorrect robot-arm orientation, approach height, or approach distance values are used.	In the teachpoint file, check and correct the robot-arm orientation, approach height value, and approach distance value. See "Setting teachpoints" on page 88.

Homing problems

Problem	Cause	Solution
The robot does not home.	The robot is in a position where it cannot home.	Disable the motors, manually move the robot into the safe zone, enable the motors, and home the robot.
	The homing offsets are incorrect.	Contact Automation Solutions Technical Support.
	The circular encoders are dirty or damaged.	Contact Automation Solutions Technical Support.
The robot crashes into the base during the homing process.	The robot moved beyond its Z-axis index.	Jog the robot upward, a few centimeters above the base, and try again.
	The Base clearance value is incorrect.	Adjust the **Base clearance** value in the **Setup** tab. See "Replacing robot grippers" on page 185 for instructions.
	The homing sensor needs adjustment.	Contact Automation Solutions Technical Support.

Related information

For information about...	See...
Direct Drive Robot component names	"Hardware components" on page 4
Software error messages	"Troubleshooting error messages" on page 208
Diagnosing problems	"Using DDR Diagnostics" on page 137
Reporting problems	"Reporting problems" on page 217

Troubleshooting error messages

The following table lists commonly encountered error messages, the causes of the errors, and ways to resolve the errors. The error messages are listed by error message ID.

If you are still experiencing problems with the robot after trying the solutions, or if an error not on the list is displayed, contact Automation Solutions Technical Support.

For protocol-related errors, see the *VWorks Automation Control User Guide*.

WARNING **Only administrators and experienced personnel should perform the procedures in this section.**

ID	Error message	Cause	Solution
124	The current speed setting <*speed*> exceeds the maximum speed specified by the newly selected labware <*speed*>. Would you like to reduce the speed setting to match the maximum speed <*speed*>?	After selecting a speed in Direct Drive Robot Diagnostics, you select a labware. The speed setting of the labware (in Labware Editor) is slower than the speed selection in Direct Drive Robot Diagnostics.	Select **Yes** to change the speed selection in Direct Drive Robot Diagnostics to match the labware speed setting. Select **No** to use the current speed selection in Direct Drive Robot Diagnostics. Note that the Labware speed setting will not be changed.
125	Failed to open a connection to <*profileName*: *errorString*>.	Connection cannot be established with the robot specified by the profile. The desired robot or the controlling computer is not connected to the system.	Make sure the robot and controller computer are both connected to the system network.
145	Failed to disable the arm power.	Connection cannot be established with the robot specified by the profile. The desired robot or the controlling computer is not connected to the system.	Make sure the robot and controller computer are both connected to the system network.
146	Failed to enable the arm power.	Connection cannot be established with the robot specified by the profile. The desired robot or the controlling computer is not connected to the system.	Make sure the robot and controller computer are both connected to the system network.

ID	Error message	Cause	Solution
167	Would you like to change the selected labware to Teaching Jig? If not, make sure the selected labware is gripped at its minimum gripper offset.	You clicked Teach Mode in Direct Drive Robot Diagnostics, but you have not yet selected the teaching jig.	Click **Yes** to select the teaching jig in Direct Drive Robot Diagnostics. Click **No** to exit the error dialog box. The existing labware is still selected. When using a labware to set teachpoints, the software assumes that the labware is held at the minimum gripper offset.
179	There are unsaved teachpoint modifications. Would you like to save?	While closing the profile, the software found unsaved teachpoint modifications.	Click **Yes** to save the changes and close the profile. Click **No** to close the profile without saving the changes.
212	This action will create <*orientation*>. This orientation already exists in this teachpoint. Would you like to exchange the parameters of these two orientations?	Changing the A1-well orientation of the selected orientation will result in duplicate orientations for a teachpoint.	Click **Yes** to keep the two A1-well orientations and exchange the parameters of these two orientations. Click **No** to exit the error dialog box without making any changes.
250	The teachpoint <*teachpoint name*> does not exist. Before starting the cycler, you must remove this teachpoint.	You are attempting to start the teachpoint cycler, but a teachpoint no longer exists. The teachpoints list in the Cycler tab is not synchronized with the teachpoints list in the Teachpoints tab. Teachpoints that were removed in the Teachpoints tab still appear in the Cycler tab.	Remove the obsolete teachpoint from the **Cycler** tab before starting the teachpoint cycler.
252	The center of the approach orientation <*plate, A1, and arm orientation*> is not within 25 mm of the center of the orientations found in the target teachpoint: <*teachpoint name*>. Continue?	All orientations of a single teachpoint should have the same center coordinates with a 25-mm tolerance along the *x*-, *y*-, or *z*-axis. The orientation you are adding is likely for a different teachpoint, because its center is greater than 25 mm from that of the target teachpoint.	Click **Continue** to add the orientation to the teachpoint despite the warning. When you save the teachpoint file, the same warning message will appear. Click **Cancel** to exit the dialog box without making the change.

ID	Error message	Cause	Solution
344	You are attempting to update the orientation <*original plate orientation, original A1 orientation, original arm orientation*> with the robot's current approach orientation: new plate orientation, new A1 orientation, new arm orientation. Because of this mismatch, the update is not allowed.	You moved the robot to a new position and the orientation (landscape/ portrait, right/left) does not match the teachpoint you selected for the update action. For example, the robot is currently in the landscape orientation but the teachpoint you selected has the portrait orientation.	Make sure you have selected the correct teachpoint for updating. Make sure you have moved the robot to the correct position and the orientation is correct.
363	Because the specified zip file name does not start with DDRFirmware, you cannot use this file to update the Direct Drive Robot firmware.	The .zip file you are using for firmware update must contain the DDRFirmware string in its name.	Make sure you selected the correct file for upgrading the firmware. The filename must start with the DDRFirmware string.
9041	Gripper motor could not initialize. If a plate is currently being gripped, removing it should allow the gripper motor to initialize.	The gripper was holding a labware when you initialized the robot.	Remove the labware, and then reinitialize.
9051	*z*-axis motor over temperature (digital).	The digital input that is connected to the *z*-axis temperature sensor indicates that this axis temperature is equal to or above approximately 110 °C.	Home the robot.
9052	*z*-axis motor over temperature (analog).	The analog input that is connected to the *z*-axis temperature sensor indicates that this axis temperature is equal to or above the factory-specified threshold.	Home the robot.
9081	Error while homing robot.	The robot grippers cannot move to the home position. An obstacle might be in the way, or the grippers are opened too far.	If the grippers are holding labware, remove the labware and retry homing. If an obstable is in the way, remove the obstacle and retry homing. Close the robot grippers and try again.
9082	Error while homing robot (fine homing error).	The robot is unable to move to the home position.	Move the robot to a different position, and then try to home the robot again.

ID	Error message	Cause	Solution
9115	Communication error (destination not set).	An internal software error occurred.	Contact Automation Solutions Technical Support.
9131	Teachpoint name not found.	An internal software error occurred.	Contact Automation Solutions Technical Support.
9132	Approach orientation index out of range.	An internal software error occurred.	Contact Automation Solutions Technical Support.
9138	Could not find the specified approach orientation.	The firmware has encountered a situation in which the desired approach orientation(s) does not exist in the specified teachpoint. For example, the operator has issued a 'Move to' command to teachpoint 'A', and specified that the Portrait, A1 away from the gripper, Lefty orientation be used. When the robot executes this command it is determined that the specified approach orientation does not exist for teachpoint 'A.'	Reset the teachpoint with the correct orientations.
9140	Final gripper position is less than target position.	The gripper settings need to be adjusted. When gripping a plate in landscape or portrait position, the gripper is closed until the labware-specified torque is reached. After reaching this torque, the grippers are stopped. The gripper position is checked against the Gripper settings found in the Setup tab. If the gripper position does not fall within the tolerance specified by these settings, this error is displayed.	In the **Direct Drive Robot Diagnostics Setup** tab, adjust the close target and the close tolerance settings.

ID	Error message	Cause	Solution
9141	Final gripper position is greater than target position.	The gripper settings need to be adjusted. When gripping a plate in landscape or portrait position, the gripper is closed until the labware-specified torque is reached. After reaching this torque, the grippers are stopped. The gripper position is checked against the Gripper settings found in the Setup tab. If the gripper position does not fall within the tolerance specified by these settings, this error is displayed.	In the **Direct Drive Robot Diagnostics Setup** tab, adjust the close target and the close tolerance settings.
9146	While picking: Error occurred during transfer from <*SRC*> to <*DST*>.	The robot was unable to move to the pick location because an obstacle was in the way.	Remove any obstacle in the robot's path and try again.
9147	While picking: Optical sensor failed to sense plate.	The software and firmware are out of date.	Update the Direct Drive Robot Diagnostics software to version 1.1 or later, and update the robot and gripper firmware to version 1.1 or later.
9149	Homing error: Home index pulse off.	Hardware error occurred in the motor, encoder, sensor, or all.	Contact Automation Solutions Technical Support.
9150	Homing error: Home index pulse on.	Hardware error occurred in the motor, encoder, sensor or all.	Contact Automation Solutions Technical Support.
9151	Homing error: Error on encoder falling edge.	Hardware error occurred in the motor, encoder, sensor or all.	Contact Automation Solutions Technical Support.
9152	Homing error: Error on encoder rising edge.	Hardware error occurred in the motor, encoder, sensor or all.	Contact Automation Solutions Technical Support.
9153	Homing error: Pulse width error found during homing.	Hardware error occurred in the motor, encoder, sensor or all.	Contact Automation Solutions Technical Support.
9154	Homing error: Error moving away from the latched position during homing.	An error occurred during the homing process.	Contact Automation Solutions Technical Support.

ID	Error message	Cause	Solution
9155	Homing error: Error moving off of index.	Hardware error occurred in the motor, encoder, sensor or all.	Contact Automation Solutions Technical Support.
9156	Homing error: Error finding next index.	Hardware error occurred in the motor, encoder, sensor or all.	Contact Automation Solutions Technical Support.
9157	Homing error: Via the look up table, the absolute position of the axis could not be determined. Move the robot to a new position and then retry homing.	Hardware error occurred in the motor, encoder, sensor or all.	Move the robot to a new position and try again.
9158	Homing error: Invalid state index specified.	Hardware error occurred in the motor, encoder, sensor or all.	Contact Automation Solutions Technical Support.
9161	Labware not present in grippers.	The software and firmware are out of date.	Update the Direct Drive Robot Diagnostics software to version 1.1 or later, and update the robot and gripper firmware to version 1.1 or later.
9163	Gripper was not empty when it should have been.	You issued a command that requires the robot to pick up a labware, but the robot is currently holding another labware.	Remove the labware from the robot's grippers and try again.
9164	Gripper should have been holding labware.	The software and firmware are out of date.	Update the Direct Drive Robot Diagnostics software to version 1.1 or later, and update the robot and gripper firmware to version 1.1 or later.
9165	Gripper servo error.	The robot bumped into an obstacle.	Remove all obstacles and try again. See the topic on recovering from servo errors.
9167	While picking: Error picking plate from <*SRC*>.	The software and firmware are out of date.	Update the Direct Drive Robot Diagnostics software to version 1.1 or later, and update the robot and gripper firmware to version 1.1 or later.
9180	Error while homing robot. Index transition was not found.	Hardware error occurred in the motor, encoder, sensor or all.	Move the robot to a new position and try again.
9183	The robot is in an indeterminate position.	Hardware error occurred in the motor, encoder, sensor or all.	Move the robot to a new position and try again.

ID	Error message	Cause	Solution
9203	Invalid secondary teachpoint specified for position interpolation.	While setting teachpoints for storage devices such as the Lid Hotel Station, an incorrect coordinate was used to determine the location of storage slots below the reference location (top-most platepad in the Lid Hotel Station).	Check the reference teachpoint, and then reset the teachpoints of the remaining storage slots.
9204	The position is outside the valid Z-axis range.	The robot is unable to move to the specified teachpoint. The specified gripper offset range results in a *z*-axis coordinate that is outside of the robot's physical limit.	Edit the teachpoint. Make sure the gripper offset range works with the desired *z*-axis coordinate.
9205	Invalid gripper offset setting.	The minimum offset value is larger than the maximum offset value.	Reset the gripper offset values.
9217	The gripper firmware is incompatible - please update your gripper firmware to the correct version.	You have updated the robot firmware, but have not yet updated the gripper firmware.	Update the gripper firmware. You must always update both firmware at the same time.
9224	Error while homing robot. Insufficient data found for commutation.	During homing of the waist, elbow, or wrist the homing process could not be completed.	Move the robot to a new position and try again.
9225	Z-axis commutation timed out.	The homing process is too long and timed out.	Move the robot to a new position and try again.
9242	While retracting after place: Error occurred during transfer from <*SRC*> to <*DST*>.	The robot was unable to retract to the safe zone because an obstacle was in the way.	Remove any obstacle in the robot's path and try again.
9244	While picking: The specified pick location would cause the robot to move beyond its limits.	The pick action requires that the robot move to a location that is out of the robot's reach.	Check and edit the teachpoint. Make sure the robot is able to reach the location.
9245	While placing: The specified place location would cause the robot to move beyond its limits.	The place action requires that the robot move to a location that is out of the robot's reach.	Check and edit the teachpoint. Make sure the robot is able to reach the location.
11028	Hard E-stop.	The Emergency Stop button was pressed.	See the topic that explains how to recover from an emergency stop. You cannot resume a run after an emergency stop.

ID	Error message	Cause	Solution
11610	Controller overheating.	The CPU exceeded its operating temperature for too long and the controller automatically turned off. If this occurs during a run, the run will automatically stop. The run cannot resume.	Wait approximatly 10 minutes for the robot to cool, power cycle the robot, and then try again.
11612	Power supply relay stuck.	The robot will not turn on.	Restart the robot. The power switch is on the front of the robot power supply. If restarting the robot does not help, the power supply unit might need to be replaced.
11613	Power supply shorted.	Power has been disabled because the motor power supply has detected that it is shorted.	The robot power supply unit might need to be replaced.
11614	Power supply overloaded.	Power has been disabled because the motor power supply has detected an overload condition.	The robot power supply unit might need to be replaced.
11615	Power supply reset stuck.	The robot motor power will not turn on.	Restart the robot. The power switch is on the front of the robot power supply. If restarting the robot does not help, the power supply unit might need to be replaced.
11616	Shutdown due to overheating.	The CPU exceeded its operating temperature for too long and the controller automatically turned off.	Wait approximatly 10 minutes for the robot to cool, power cycle the robot, and then try again.
13100	Position tracking error exceeded threshold.	The robot was unable to follow its intended trajectory, possibly because it bumped into an obstacle.	Remove all obstacles and try again.
13104	Motor duty cycle exceeded.	An obstacle is preventing the robot from moving.	Remove all obstacles and try again.
13105	Motor stalled.	The robot bumped into an obstacle.	Remove all obstacles and try again.
13106	Axis over-speed.	This error is generated when power is enabled or during normal running if the system detects that an axis has violated a speed limit.	Remove all obstacles and try again.

ID	Error message	Cause	Solution
13107	Amplifier over-current.	An obstacle is preventing the robot from moving.	Remove all obstacles, home the robot, and try again.
13109	Amplifier under-voltage.	The DC motor bus has dropped too low.	Check all cable connections. If the cables are correctly connected, the power supply might be be failing. In the **Direct Drive Robot Diagnostics Advanced** tab, note the **Bus Voltage** values and report the values to Automation Solutions Technical Support.
13113	Motor commutation setup failed.	The configuration files are corrupted.	Click Retry in the error dialog box.
13117	Amplifier RMS current exceeded.	An obstacle is preventing the robot from moving.	Remove all obstacles and try again.
13122	Position tracking error exceeded threshold.	The robot was unable to follow its intended trajectory, possibly because it bumped into an obstacle.	Remove all obstacles and try again.

Related information

For information about...	See...
Direct Drive Robot component names	“Hardware components” on page 4
Hardware problems	“Troubleshooting hardware problems” on page 203
Recovering from emergency stops	“Recovering from an emergency stop” on page 198
Recovering from servo errors	“Recovering from servo errors” on page 201
Safety	*Direct Drive Robot Site Preparation and Safety Guide*
Reporting problems to Agilent Technologies	“Reporting problems” on page 217

Reporting problems

Contacting Automation Solutions Technical Support

If you find a problem with the Direct Drive Robot, contact Automation Solutions Technical Support at one of the following:

Europe

Phone: +44 (0)1763850230

email: euroservice.automation@agilent.com

US and rest of world

Phone: 1.800.979.4811 (US only) or +1.408.345.8011

email: service.automation@agilent.com

Note: You can also send a software bug report from within the VWorks software.

Reporting hardware problems

When contacting Agilent Technologies, make sure you have the serial number of the device ready.

Reporting software problems

When you contact Automation Solutions Technical Support, make sure you provide the following:

- Short description of the problem
- Software version number
- Error message text (or screen capture of the error message dialog box)
- Screen capture of the About VWorks software dialog box.
- Relevant software files

To find the VWorks software version number:

In the VWorks software, select **Help > About VWorks.**

To find the Diagnostics software version number:

1 Open **Diagnostics.**

2 Read the version number on the title bar of the diagnostics window.

To send compressed protocol and associated files in VZP format:

In the VWorks software, select **File > Export** to export and compress the following files:

- Protocol file
- Device file (includes the device profile and teachpoint file)
- Labware definitions
- Liquid classes
- Pipette techniques
- Hit-picking files

- Plate map files
- Barcode files
- Error library
- Log files
- Form file (*.VWForm)

Reporting user guide problems

If you find a problem with this user guide or have suggestions for improvement, send your comments using one of the following methods:

- Click the feedback button ( ) in the online help.
- Send an email to documentation.automation@agilent.com.

Related information

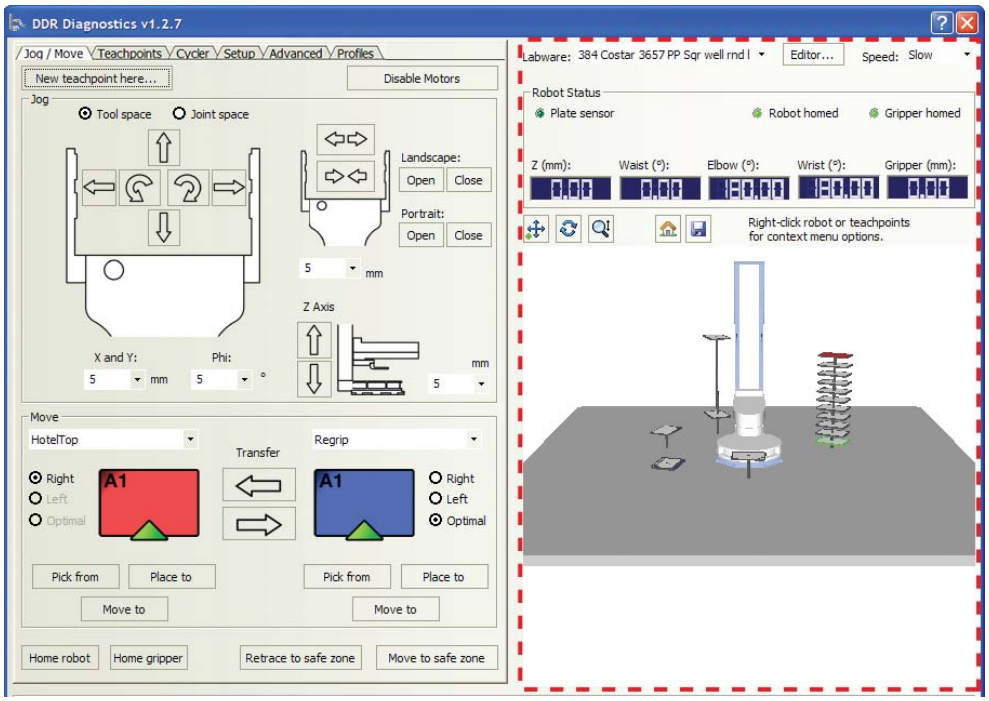
For information about...	See...
Hardware problems	"Troubleshooting hardware problems" on page 203
Software error messages	"Troubleshooting error messages" on page 208
Recovering from emergency stops	"Recovering from an emergency stop" on page 198
Recovering from initialization errors	"Resolving robot initialization errors" on page 200
Recovering from servo errors	"Recovering from servo errors" on page 201
Safety	*Direct Drive Robot Site Preparation and Safety Guide*

A
Quick reference

This appendix provides a quick reference of menu commands, selections, options, and status information in the DDR Diagnostics dialog box. The topics are:

- "Robot status area" on page 220
- "Log area" on page 222
- "Jog/Move tab" on page 223
- "Teachpoints tab" on page 229
- "Cycler tab" on page 232
- "Setup tab" on page 233
- "Advanced tab" on page 235
- "Profiles tab" on page 237

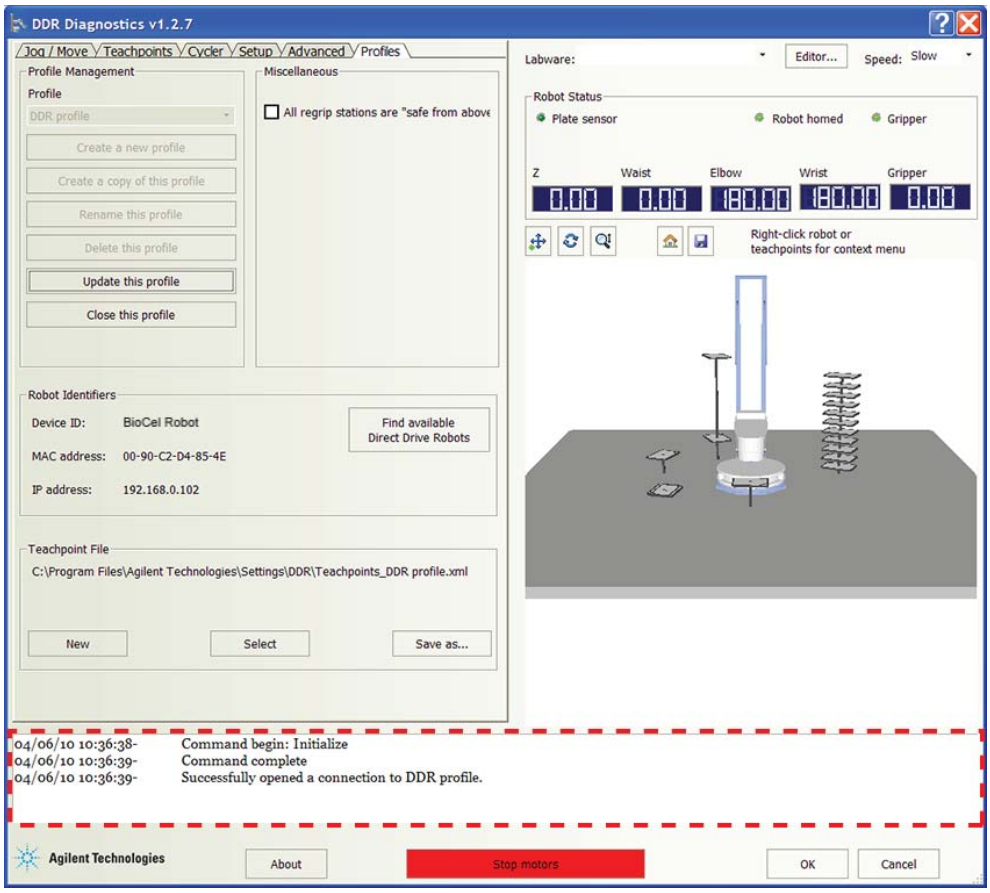
Robot status area



Selection or command	Description
Labware	Allows you to select a labware.
Editor	Opens the Labware Editor.
Speed	Sets the robot speed: Slow, Medium, or Fast.
Plate sensor	Indicates the presence of labware in the robot grippers. If the indicator light is on, a labware is in the robot grippers. If the indicator light is off, the sensor does not detect a labware in the robot grippers.
Robot homed	Indicates that the robot is in the factory-defined home position.
Gripper homed	Indicates that the robot grippers are in the factory-defined home position.
Z (mm)	Displays the current *z*-axis coordinate relative to the home position.
Waist (°)	Displays the current waist coordinate relative to the home position.
Elbow (°)	Displays the current elbow coordinate relative to the home position.

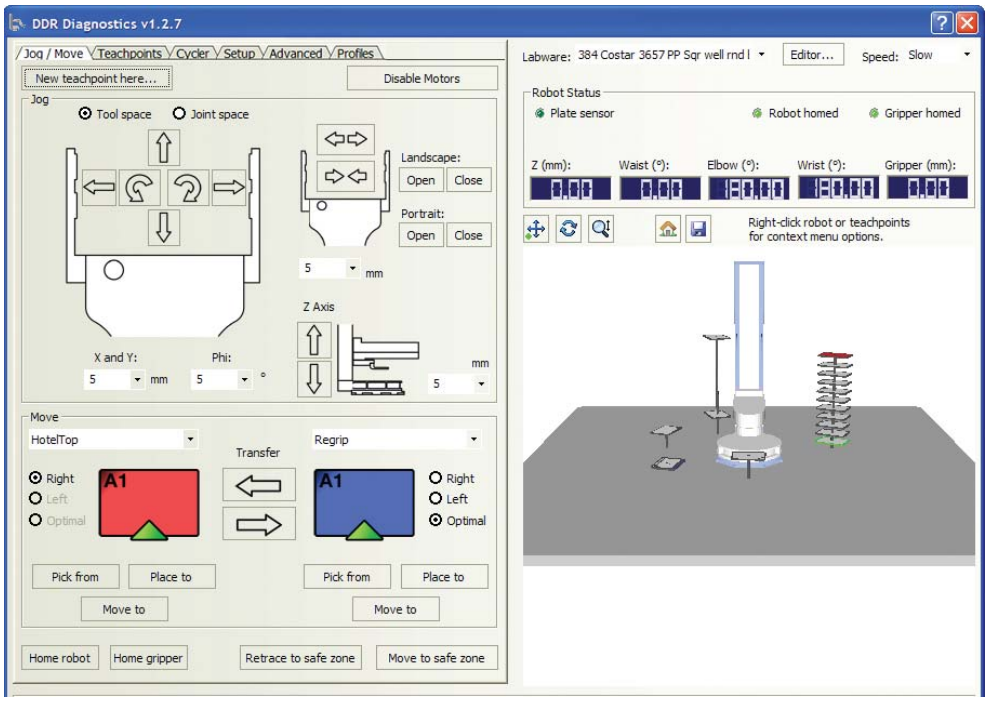
Selection or command	Description
Wrist (°)	Displays the current wrist coordinate relative to the home position.
Gripper (mm)	Displays the current distance between the two grippers.
	Pans, or moves the image. Click the button, and then drag the image in the desired direction.
	Rotates the image. Click the button, and then drag the image to rotate it in the desired direction. Alternatively, click the middle mouse button or wheel, and then drag the image to rotate it.
	Increases or reduces the image magnification. Click the button, and then drag the image upward or downward to increase or decrease the magnification respectively. Alternatively, scroll the mouse wheel to change the magnification.
	Resets the image to the default view.
	Saves the current view as the default view.

Log area



Shows the status of the commands, actions, and progress as you work in the dialog box.

Jog/Move tab

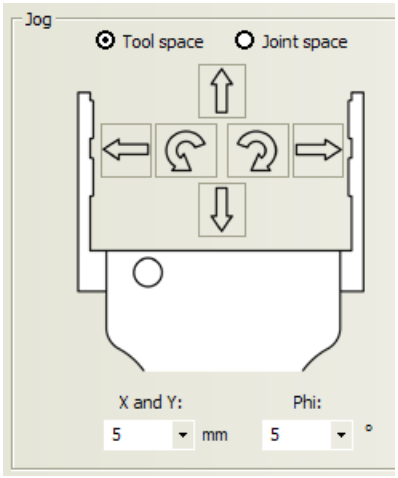


General commands

Command	Description
New teachpoint here	Creates a new teachpoint at the current coordinates.
Disable Motors/Enable Motors	Disables or enables the robot joint motors. When disabling the motors, the robot will first finish the current command before stopping. For safety reasons, disabling the motors disables the joint motors only. You cannot disable the *z*-axis motor.
Home robot	Sends the robot to the factory-defined home position for each of the axes of motion.
Home gripper	Sends the grippers to the factory-defined home position. *Note:* Homing the grippers does not home the rest of the robot.

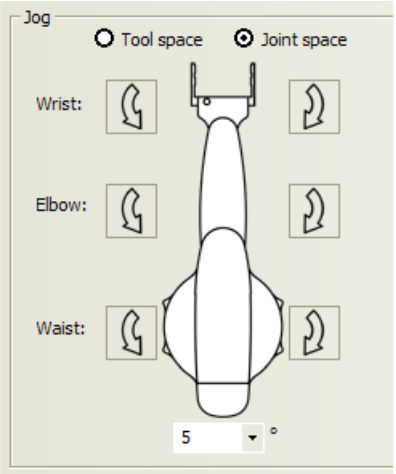
Command	Description
Retrace to safe zone	Enables the robot to search for the closest teachpoint, and then use the path from that teachpoint to return to the safe zone. If the robot is unable to find a teachpoint nearby, it will retreat into the safe zone by retracing the path it took to reach the current location. Use the Retrace to safe zone command when, for example, the robot grippers are within a device, and using the Move to safe zone command might cause the robot to run into the sides of the device or other obstacles.
Move to safe zone	Enables the robot to search for the closest teachpoint, and then use the path from that teachpoint to return to the safe zone. If the robot is unable to find a teachpoint nearby, it retracts radially into the safe zone. Use the Move to safe zone command if it is close to a teachpoint and the path from that teachpoint to the safe zone is clear or obstacles.
Stop Motors	Immediately cuts power to the robot motors, thus stopping the robot.
About	Displays the DDR Diagnostics version number and copyright information.

Jog area: Tool space commands



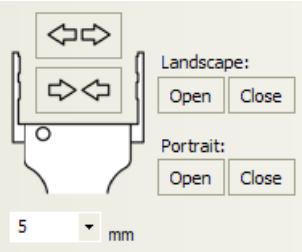
Command or parameter	Description
Tool space	Displays the jog buttons to move the robot waist, elbow, wrist, and arm so that the labware moves to its target location along the *x*- or *y*-axis. In addition, you can rotate the labware (*Phi* angle) and move the robot arm up and down along the mast or *z*-axis. In tool space, all movements are measured with respect to the center of the labware.
Tool space jog buttons: X: Y: Phi:	Jogs the robot in the specified direction by the specified distance in millimeters or by the specified angle.
X and Y jog increment	Specifies the distance, in millimeters, the robot moves when you click an *x*- or *y*-axis jog button.
Phi jog increment	Specifies the distance, in degrees, the labware rotates when you click a rotating jog button.

Jog area: Joint space commands



Command or parameter	Description
Joint space	Displays the jog buttons to rotate the robot's entire body about its waist joint, rotate its forearm about its elbow joint, and rotate its hand about the wrist joint. In addition, you can move the robot arm up and down along the mast or *z*-axis.
Wrist/Elbow/Waist jog buttons:	Jogs the robot in the specified direction by the specified degrees.
Joint jog increment	Specifies the angle, in degrees, the robot rotates when you click a rotating jog button.

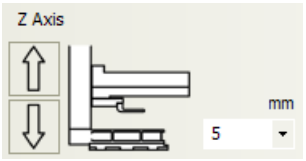
Jog area: Gripper commands

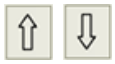


Command or parameter	Description
Landscape: Open/Close	Opens or closes the robot grippers to accommodate the landscape labware orientation.

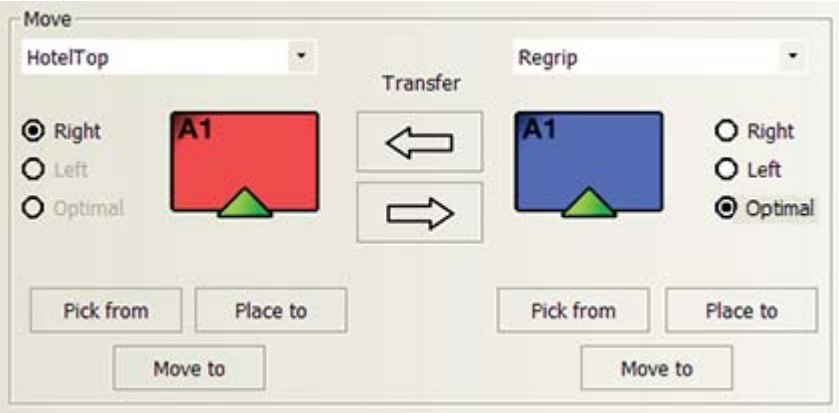
Command or parameter	Description
Portrait: Open/Close	Opens or closes the robot grippers to accommodate the portrait labware orientation.
Gripper jog buttons:	Opens or closes the robot grippers by the specified distance.
Gripper jog increment	Specifies the distance, in millimeters, the robot grippers move when you click an open or close gripper jog button.

Jog area: Z-axis commands



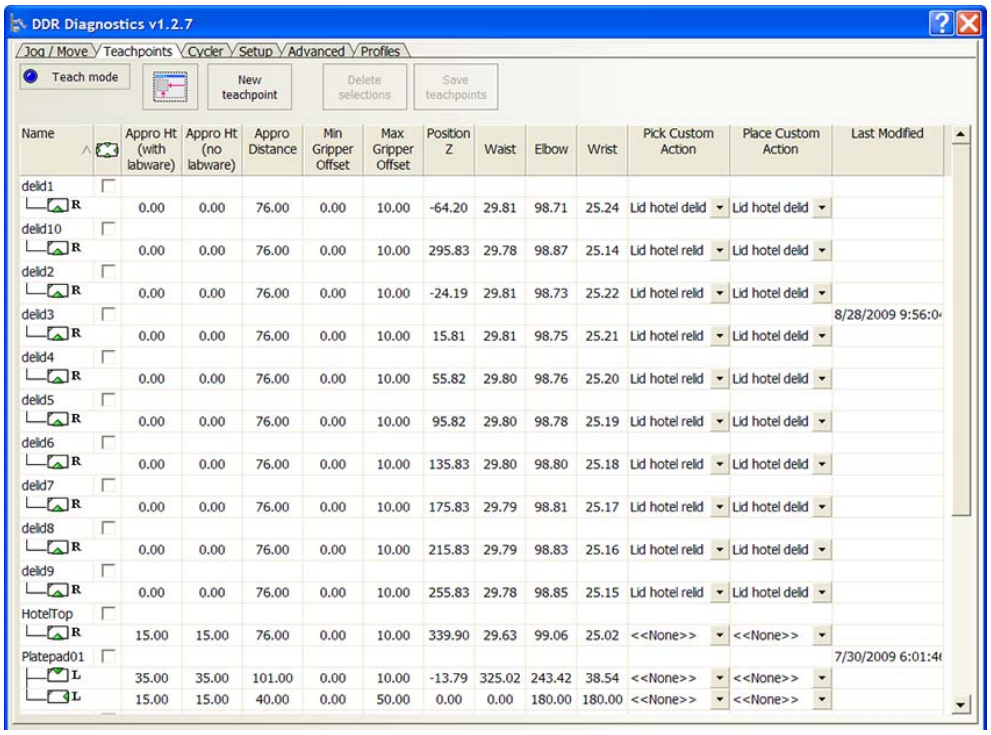
Command or parameter	Description
Z Axis jog buttons: 	Jogs the robot along the *z*-axis in the specified direction by the specified distance.
Z Axis jog increment	Specifies the distance, in millimeters, the robot moves when you click one of the Z Axis jog buttons.

Move area



Selection or command	Description
Teachpoint selection	Allows you to select from the list of available teachpoints.
Right/Left/Optimal	Specifies the robot-arm orientation at the selected teachpoint.
Transfer buttons:	Picks up labware from a selected teachpoint and places the labware at the other selected teachpoint.
Pick from	Picks up labware from the selected teachpoint.
Place to	Places labware at the selected teachpoint.
Move to	Moves the robot grippers to the selected teachpoint.

Teachpoints tab



Commands

Command	Description
Teach mode	Enables you to move the robot arm and hand freely without resistance.
(Maximize/Minimize)	Displays all of the columns or displays the first few columns in the teachpoints table.
New teachpoint	Adds a new teachpoint in the table.
Delete selections	Deletes the selected teachpoints.
Save teachpoints	Saves the changes made to the teachpoints.

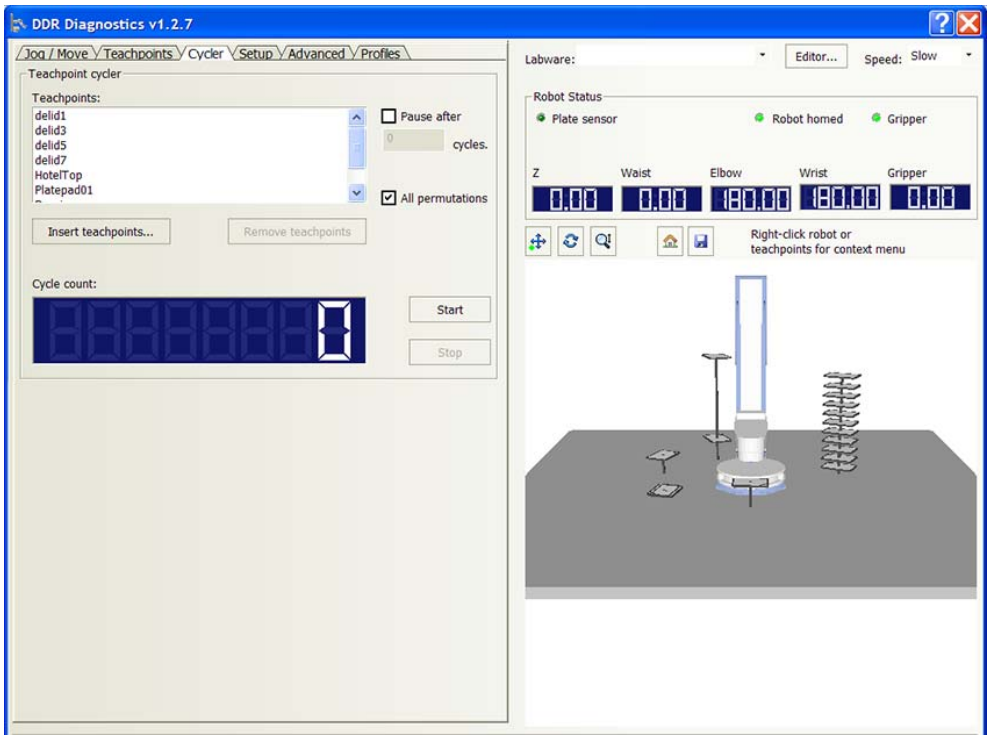
Teachpoints table

Column name	Description
Name	The name of the teachpoint. To change the name, double-click the box and type the new name.

Column name	Description
Orientation	The orientation of the labware from the robot's perspective. Double-click to change the A1 well orientation. *Note:* You cannot change the robot-arm orientation (R or L) or the labware orientation (portrait or landscape). The software automatically sets these orientations when you set the teachpoint.
Regrip Station	The regrip station designation. Select the check box to designate the teachpoint as a regrip station. *Note:* Regrip stations cannot be used for other purposes such as deadlock avoidance.
Approach Ht (with labware)	The height clearance, in millimeters, the robot must maintain above the teachpoint as it moves towards or away from the teachpoint with labware in its grippers.
Approach Ht (no labware)	The height clearance, in millimeters, the robot must maintain above the teachpoint as it moves towards or away from the teachpoint with no labware in its grippers.
Approach Distance	The distance, in millimeters, from the teachpoint within which the robot must: • Maintain the specified approach height. • Move in a straight line toward or away from the teachpoint.
Minimum Gripper Offset	The vertical distance, in millimeters, from the teachpoint to the lowest point where the grippers will hold the labware at the teachpoint. The default value is 0 mm. This value is used with the Maximum gripper offset value to define a range within which the grippers can hold the labware at the teachpoint location. **IMPORTANT** During the run, the VWorks software checks the gripper offset range defined in this tab and the range in the labware's definition. **IMPORTANT** For regrip stations, make sure the range can accommodate all labware.

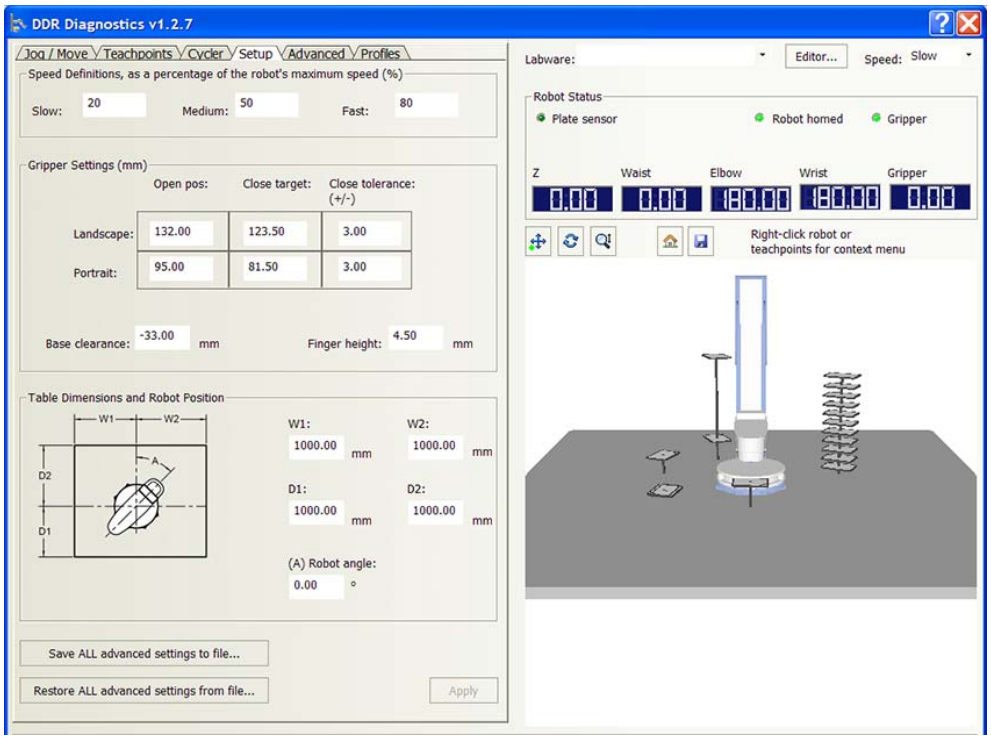
Column name	Description
Maximum Gripper Offset	The vertical distance, in millimeters, from the teachpoint to the highest point where the grippers will hold the labware at the teachpoint. The default value is 10 mm. This value is used with the Minimum gripper offset value to define a range within which the grippers can hold the labware at the teachpoint location.
Position Z	The *z*-axis coordinate of the robot measured in millimeters.
Waist	The waist joint coordinate.
Elbow	The elbow joint coordinate.
Wrist	The wrist joint coordinate.
Pick Custom Action	The actions that the robot will perform at the teachpoint. Use the Pick Custom Action to: • Relid labware at a Lid Hotel Station. • Stir the labware at the teachpoint.
Place Custom Action	The actions that the robot will perform at the teachpoint. Use the Place Custom Action to: • Delid labware at the Lid Hotel Station or the Vacuum Delid Station. • Press down labware to secure placement.
Last modified	The timestamp that shows when a teachpoint was changed.

Cycler tab



Command or option	Description
Insert teachpoints	Allows you to select the desired teachpoints from the existing teachpoints list.
Remove teachpoints	Removes the selected teachpoints from the Teachpoints list.
Pause after ___ cycles	Pauses the cycling after the specified number of cycle times.
All permutations	Runs the all-permutations cycling sequence.
Start/Pause	Starts the cycling.
Stop	Stops the cycling. The robot will stop after the current pick-and-place action.

Setup tab



Speed definitions

The following robot speeds are definable as a percentage of the factory-set maximum speed. The default percentage settings are as follows:

Speed	Default
Slow	20%
Medium	50%
Fast	80%

Gripper Settings (mm)

Command or option	Description
Open pos	The distance, in millimeters, between the grippers when they are open. The default values are 132 mm (landscape) and 95 mm (portrait).

Command or option	Description
Close target	The approximate distance, in millimeters, between the grippers when they are closed. The default values are 123.5 mm (landscape) and 81.5 mm (portrait). The Close target value is always used in conjunction with the Close tolerance value.
Close tolerance	The distance, in millimeters, the Close target is allowed to vary without causing an error. The default value is +/-3 mm.
Base clearance	The *z*-axis coordinate at which the bottom of the grippers touches the top of the base.
Finger height	The height of the grippers, measured from the midpoint of the gripper pads.

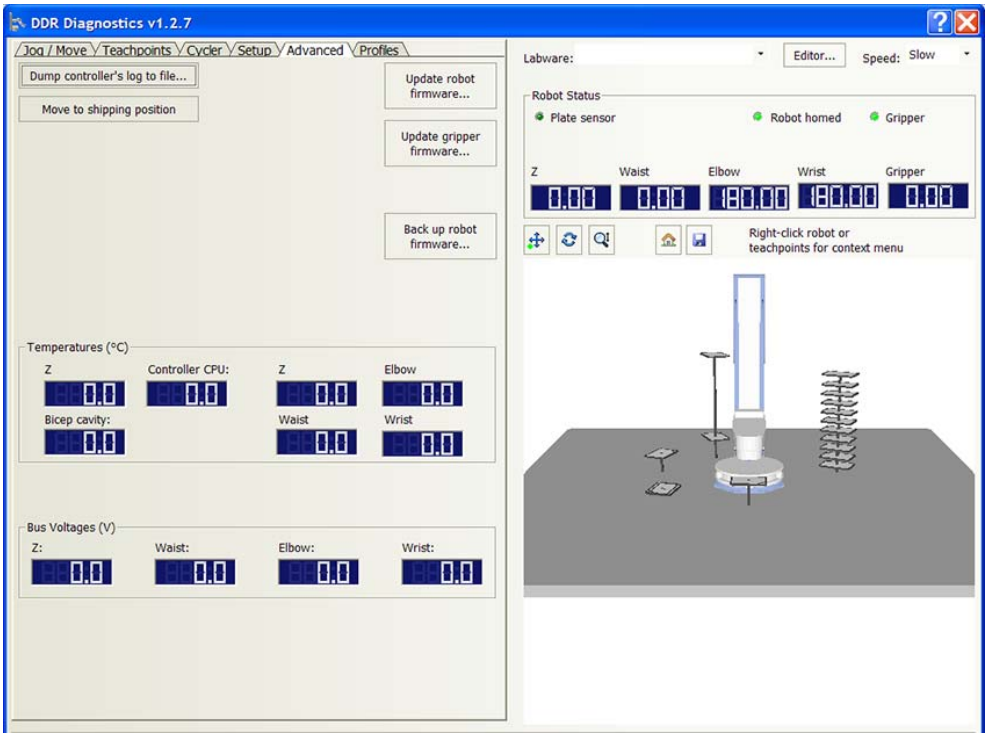
Table dimensions and Robot Position

Command or option	Description
W1/2	The width of the robot-attachment surface. W1 and W2 specify the lengths of the two segments of the width. The line that intercepts the end of W1 and the beginning of W2 runs through the center of the robot base.
D1/2	The depth of the robot-attachment surface. D1 and D2 specify the lengths of the two segments of the depth. The line that intercepts the end of D1 and the beginning of D2 runs through the center of the robot base.
Robot angle	The angle between the robot 0° position relative to the *D*-axis.

Commands

Command or option	Description
Save ALL advanced settings to file	Saves the current robot settings to a file.
Restore ALL advanced settings to file	Restores the robot settings from the selected file.

Advanced tab



Commands

Command or option	Description
Dump controller's log to file	Saves the robot controller log to a file.
Move to shipping position	Tucks the robot forearm and hand under the bicep to permit the installation of the shipping brace.
Update robot firmware	Backs up the existing robot firmware, and then updates, restores, or installs the selected firmware. **Caution:** If you have robot firmware version 1.1 or earlier, contact Automation Solutions Technical Support before starting the update procedure.
Update gripper firmware	Updates the selected gripper firmware.
Back up robot firmware	Backs up the robot firmware.

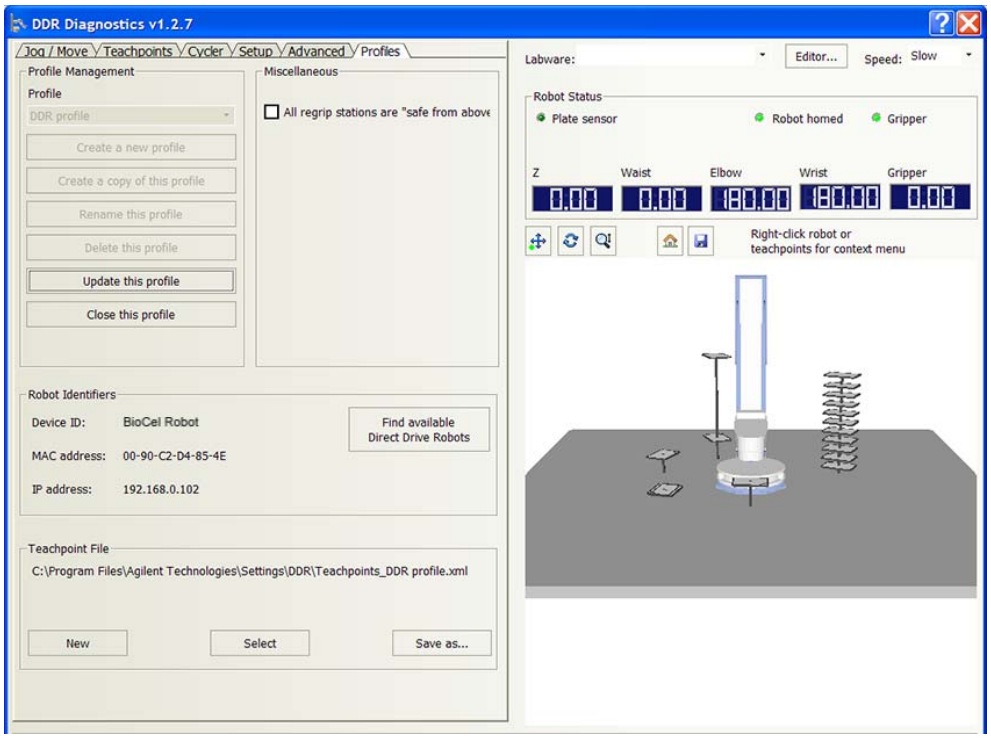
Temperatures (°C)

Component	Description
Z motor	The temperature of the *z*-axis motor.
Bicep cavity	The temperature of the bicep interior.
Controller CPU	The temperature of the contoller CPU.
Z amplifier	The temperature of the *z*-axis amplifier.
Waist	The temperature of the waist interior.
Elbow	The temperature within the elbow.
Wrist	The temperature inside the wrist.

Bus Voltages (V)

Component	Description
Z motor	The voltage delivered to the *z*-axis motor.
Waist	The voltage delivered to the waist motor.
Elbow	The voltage delivered to the elbow motor.
Wrist	The voltage delivered to the wrist motor.

Profiles tab



Profile Management area

Selection or command	Description
Profile name	Displays the selected profile. Also allows you to select from the list of available profiles.
Create a new profile	Creates a new profile.
Create a copy of this profile	Creates a duplicate copy of the selected profile.
Rename this profile	Renames the selected profile.
Delete this profile	Deletes the selected profile.
Update this profile	Saves changes to the selected profile.
Initialize this profile	Initiates communication with the robot using the selected profile.

Robot Identifiers area

Display value or command	Description
Device ID	Displays the name of the robot. This name is displayed in the Discovered BioNet Devices dialog box.
MAC address	Displays the MAC address that identifies the robot. The address is displayed in the Discovered BioNet Devices dialog box.
IP address	Displays the IP address that uniquely identifies the robot. The address is displayed in the Discovered BioNet Devices dialog box.
Find available Direct Drive Robot	Opens the Discovered BioNet Devices dialog box so that you can locate and select the robot.

Teachpoint File area

Display value or command	Description
File path	Displays the location of the selected teachpoint file.
New	Allows you to create a new teachpoint file.
Select	Allows you to select an existing teachpoint file.
Save as	Allows you to change the teachpoint file name or storage location from the default. The default teachpoint file name is Teachpoints_<profilename>.xml, where <profilename> is the name of the profile. The software saves the file in the C:\VWorks Workspace folder.

Miscellaneous area

Option	Description
All regrip stations are safe from above	Indicates sufficient clearance at all regrip stations to permit the robot to rotate its wrist at the approach height. Use this option if one or more regrip stations will be used for changing labware orientation.

B

Spare parts

This appendix lists the Direct Drive Robot spare parts you can order from Automation Solutions. The topics are:

- "Ordering information" on page 240
- "Spare parts list" on page 241

Ordering information

Contacting Customer Service

To order spare parts, contact Automation Solutions Customer Service using one of the following methods:

Contact method	Information
Telephone	1.866.428.9811 +1.408.345.8356
Email	orders.automation@agilent.com

Be sure to provide the part numbers of the parts you need.

Related information

For information about...	See...
Reporting problems	“Reporting problems” on page 217
Spare parts list	“Spare parts list” on page 241

Spare parts list

Part name	Part number
Direct Drive Robot (in shipping brace):	
Cable connection on the side, or	23083-211
Cable connection on the bottom	23083-212
Power supply:	
Fuses on the back side, or	G5411-60010
Fuses inside	G5411-60005
2-mm hex wrench	G5550-04237
4-mm hex wrench	G5550-04234
5-mm hex wrench	G5550-01523
M6 mounting bolts (8)	G5550-02705
Power supply mounting	
Pan-head Phillips machine screws (4)	G5550-09078
M05 split lock washer (4)	G5550-02453
M05 flat washer (4)	G5550-02439
Teaching jig	G5550-23357
Regrip station assembly:	
Regrip station	G5550-20020
M6 mounting screw	G5550-02697
Gripper pad replacement parts:	
Gripper pads (2)	G5550-23287
Cap screws (6)	5023-1658
Star-head wrench	5023-1659
Threadlocking solution	5188-8370
Power cable	Request by country
Robot cable	G5550-23704
Emergency stop pendant and cable	16971-001
Ethernet cable	G5550-09363
VWorks software CD:	
Benchtop license, or	08330-402
System license	08330-403
Direct Drive Robot Site Preparation and Safety Guide	G5430-90001

Related information

For information about...	See...
Ordering information	“Ordering information” on page 240
Reporting problems	“Reporting problems” on page 217
Installing the robot	“Installation and setup workflow” on page 32
Replacing the gripper pads	“Replacing robot gripper pads” on page 181
Replacing the grippers	“Replacing robot grippers” on page 185
Safety	*Direct Drive Robot Site Preparation and Safety Guide*

Glossary

clamps (BenchCel) The components inside of the stacker head that close and open the stacker grippers during the loading, unloading, downstacking, and upstacking processes.

controlling computer The lab automation system computer that controls the devices in the system.

cycle See seal cycle.

deadlock An error that occurs when the number of locations available in the system is less than the number of microplates in the system. Because the microplates cannot move to the expected locations, the protocol pauses.

device An item on your lab automation system that can have an entry in the device file. A device can be a robot, an instrument, or a location on the lab automation system that can hold a piece of labware.

device file A file that contains the configuration information for a device. The device file has the .dev file name extension and is stored in the folder that you specify when saving the file.

downstack The process in which a microplate is moved out of the stack.

error handler The set of conditions that define a specific recovery response to an error.

home position The position where all robot axes are at the 0 position (the robot head is approximately at the center of the x-axis and at 0 of the z-axis, and the robot arms are perpendicular to the x-axis).

homing The process in which the robot is sent to the factory-defined home position for each axis of motion.

hot plate (PlateLoc) A heated metal plate inside the sealing chamber that descends and presses the seal onto the plate.

insert A pad placed under the plate to support the bottom of the wells for uniform sealing.

location group A list of labware that can be moved into or out of particular slots in a storage device.

plate group A list of specific labware that can be moved into or out of a storage device without regard for the slot locations.

plate instance A single labware in a labware group that is represented by the process plate icon.

plate stage The removable metal platform on which you load a plate.

plate-stage support The structure on which you load a plate stage. The plate-stage support extends when the door opens.

profile The Microsoft Windows registry entry that contains the communication settings required for communication between a device and the VWorks software.

process A sequence of tasks that are performed on a particular labware or a group of labware.

protocol A schedule of tasks to be performed by a standalone device, or devices in the lab automation system.

regrip station A location that enables the robot to change its grip orientation (landscape or portrait), or adjust its grip at the specified gripping height. Grip height adjustment might be necessary after a robot picks up a labware higher than the specified gripping height because of physical restrictions at a teachpoint.

robot grippers The components that the robot uses to hold labware.

run A process in which one or more microplates are processed. In a standalone device, the run consists of one cycle. In a lab automation system, a run can consist of multiple cycles that are automated.

safe zone The boundary within which the robot is allowed to move without colliding with external devices.

seal cycle The process in which a single plate is sealed on the PlateLoc Sealer.

seal entry slot The narrow entry on the back of the PlateLoc Sealer where the seal is inserted into the device.

seal-loading card A rectangular card that is used to facilitate the seal loading process on the PlateLoc Sealer.

seal-roll support The triangular structures at the top of the PlateLoc Sealer where a roll of seal is mounted.

sealing chamber The area inside of the PlateLoc Sealer where the seal is applied to a plate.

shelves (BenchCel) The components inside of the stacker head that provide leveling surfaces for the microplates, thus ensuring accurate robot gripping, during the downstacking process.

stacker grippers The padding at the bottom of the stacker racks that hold microplates when a microplate is loaded, downstacked, or upstacked.

subprocess A sequence of tasks performed as a subroutine within a protocol. Typically the subprocess is performed by a single device type, such as the Bravo device.

task An operation performed on one or more labware.

task parameters The parameters associated with each task in a protocol. For example, in a labeling task, the parameters include the label value.

teachpoint A set of coordinates that define where the robot can pick up or place labware and the location of a known object.

teachpoint file The XML file that contains the settings for one or more device teachpoints.

touch screen The interface on the front of the PlateLoc Sealer where sealing parameters are set, the seal cycle can be started or stopped, and the seal cycle can be monitored.

upstack The process in which a microplate is moved back into the stack.

waypoint A set of coordinates that define a location the robot passes through on its way to a teachpoint.

workspace The boundary within which the robot can move without limitations.

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